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1996-97
Research Overview Report

Government Science and Technology Programs and Budgets

ASRA

ALBERTA SCIENCE AND RESEARCH AUTHORITY

1996-97
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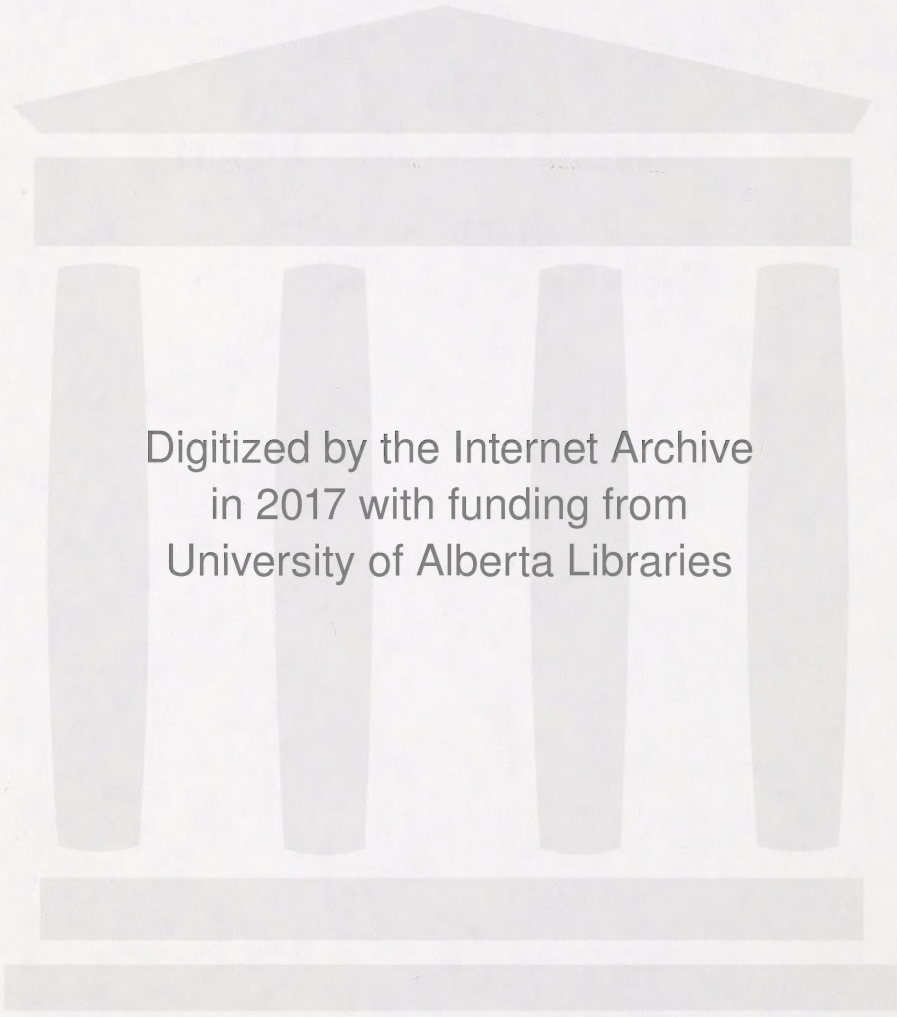
Government Science and Technology Programs and Budgets

Alberta Science and Research Authority

December, 1996



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1.0 Executive Summary

Introduction

Science and the technology flowing out of research have already had a significant impact on the development of the economy of the province and the overall welfare of Albertans. While Alberta has abundant natural resources, successful resource development has depended on technological advances to overcome significant barriers to development.

Science and research are recognized as key to meeting today's economic and social challenges. They are vital for building an innovative economy and social structure for Albertans now and into the 21st century. If Alberta is to continue to realize the economic and social benefits of science and technology in the 1990s and beyond, increased government investment in science and research is required together with improved and integrated research management.

Report Overview

This report was prepared by the Alberta Science and Research Authority (ASRA) and the Alberta Technology and Research Advisory Committee (TRAC). It is based on the departmental research business plans, as approved by the Government of Alberta in March, 1996. The report presents the research and development (R&D) and related scientific activities (RSA) plans, programs and proposed budgets for 1996/97 of the performing and funding government departments and agencies (Tables 1.1 and 1.2, Figure 1.1).

The report also includes some identified socio-economic impacts of the research programs and some of the knowledge and technology outputs that will produce socio-economic benefits. Performance measures for research and development, as in other areas, are being developed to help gauge the effectiveness of the programs.

The 1996-97 science and technology (S&T) proposed investment by the departments and agencies is $165.98 million, which is composed of $110 million identified for R&D and the remainder for related scientific activities such as technical surveys, library services for research, museum services and other activities.

Key Highlights Of Accomplishments

University Research

The University of Alberta and the University of Calgary are now in the top tier of research-intensive universities in Canada. Their technology transfer programs have created numerous spin-off companies, creating thousands of new jobs for Albertans.

Agriculture and Food Research

Alberta researchers have identified copper deficiency as a main cause of depressed cereal yields across Alberta. The potential return on the investment in copper deficiency research may total over $315 million per year.

An economic analysis of the impact of the investment made in developing new wheat varieties showed a return of over $38 to the provincial economy for every dollar invested. This was reflected in the steady increase in farm cash receipts generated by crop sales from $1.3 billion in 1987 to $1.6 billion in 1990 and $2.5 billion in 1995.

Successful spawning of grass carp (fish that eat aquatic weeds) has led to a biological alternative to chemical weed control in irrigation canals and dugouts.

Alberta's cattle and sheep nutrition and swine disease control research programs showed a return of $30 to the provincial economy for every dollar invested. The results of the research have helped livestock sales, particularly beef cattle, to steadily grow over the last five years. Receipts for livestock and livestock products increased from $2.2 billion in 1991 to $3.0 billion in 1995. Alberta is now the national leader in beef production and the fifth largest in North America. Alberta's total farm cash receipts increased from $4.2 billion in 1991 to $5.8 billion in 1995.

The application of research results, new knowledge and technology is fueling growth in Alberta's food and beverage industry. The annual value of shipments from the industry is rising steadily. It has risen from $4.5 billion in 1988 to $5.9 billion in 1995. It is expected to reach $20 billion by 2005.

Technology Infrastructure

An estimated 1000 jobs have been created over the past few years as the result of research projects involving the Alberta Microelectronic Centre.

Telecommunication Research Labs (TRLabs) is now the largest, collaborative, non-profit telecommunications research initiative in Canada. Over 50 technology applications were developed in 1995.

The Laser Institute successfully entered the US market with laser cutting technology and services. The value of 1995/96 direct exports reached $1 million.

Through the WESTAIM initiative, six major advanced materials projects have advanced to commercial or pre-commercial consideration.

The Networks of Centres of Excellence Program leverages industry support for commercially relevant research. There have been 13 invention disclosures to the University of Alberta's Industry Liaison Office.

Forestry and Forest Products Research

Driven by top-notch research and development, Alberta has dramatically increased its production of pulp, newsprint, oriented strandboard and medium density fibreboard. The sector has 20,000 direct jobs and provides 30,000 indirect jobs.

Commercial laminated beams and roofing shakes developed from Alberta spruce and pine are competing successfully worldwide against traditional wood species such as Douglas fir and cedar.

An artificial intelligence research group was established at the University of Alberta dedicated to process and quality control and assurance, and production management of processes in Alberta pulp mills. The new technology development by this group will improve quality and reduce production costs.

An agri-fibre pulp process to produce a dietary supplement for the food industry was developed and commercialized. The plant employs 16 local residents and uses surplus straw.

Energy Research

The Alberta Energy research program is aimed at ensuring that the necessary technologies are available to industry when they are needed for the economic production and processing of Alberta's energy and mineral resources.

After 18 years of research and development, steam assisted gravity drainage technology (SAGD) is starting to be used for in-situ recovery of oil from the oil sands. At least 20 companies are involved in SAGD pilot and commercial projects that total close to $1 billion.

Environmental Research

Five varieties of native plants have been developed by the Alberta Environmental Centre and commercialized for use in reclaiming high elevation disturbed sites in western Canada and potentially around the world.

Information was developed which will allow forest harvesting machinery to operate without compacting or degrading forest soils. This will help maintain the long-term structural integrity and productivity of forest soils.

Studies are being undertaken on the effects of livestock exposure to petroleum pollutants, sour gas, and hydrogen sulphide. They will lead to methods to protect cattle from potentially hazardous substances and conditions, and will save cattle producers from unnecessary losses.

A surface aeration system was developed to aerate lakes susceptible to winterkill of fish populations. Winterkill in many Alberta lakes is a major limitation to the development of recreational fisheries.

Health Research

Researchers supported by the Alberta Heritage Foundation for Medical Research have earned international acclaim for their pioneering work in areas such as: heart attack therapy, transplantation of insulin-producing cells for diabetics, nerve regeneration, cholesterol studies, the cell biology and genetics of cancer, juvenile diabetes, drugs for viral infections including hepatitis B, electrical therapy for paralyzed people, vaccine development for malaria, meningitis, and diabetes, improved understanding of arthritis, causes of high blood pressure, diagnostic tests for ulcers, lupus, knee injury, cancer, and other conditions.

Major discoveries by Alberta cancer researchers have put the province in the top ranks of cancer research. Discoveries on the relationship between radiation damage and tissue hypoxia are leading to new radiation treatment strategies. Basic research has led to advances in understanding tumor invasion and metastasis, control of cell growth, mutation and inheritance of cancer.

Alberta Research Council

The Alberta Research Council (ARC) directly contributes more than $105 million annually to the provincial economy. A 1996 output performance survey of ARC client companies determined ARC's investment to impact ratio to exceed 5—more than $5 of wealth was created for each $1 investment by the government in ARC.

Biopharmaceutical research originating from the University of Alberta is making its way to commercial practice via ARC's strategic alliance with Synsorb Biotech Inc. and Glycomed Inc.

Working with ARC, Edmonton-based Poly-Pacific Inc. developed a paint stripping technology. Fourteen new jobs have been created and the product is marketed in the US, Europe, and southeast Asia.

ARC expanded its development facilities for wood composite panels. This has resulted in improved access and faster turnaround for clients for pilot runs of medium density fibreboards, overlays and oriented strandboard. ARC expects—through its clients and partners—to contribute an additional $10 million to Alberta's economy as a direct result of this expansion.

The Computer Modelling Group, Calgary, has sold a unique reservoir visualization software in 20 countries. The 3-D visualization system was developed under two joint research ventures with ARC. Since completing its work with ARC in 1994, the company has hired 10 employees and increased its annual revenue by $1 million.

Transportation Research

Two new highway pavement test sections were constructed in Alberta. They will demonstrate the field performance of SUPERPAVE mix designs under the SHRP Asphalt Program.

Key Highlights of Research Plans

University Research

Beginning in the 1996/97 fiscal year, an additional $2 million per year will be specifically targeted over the next three years for promoting university research excellence.

Agriculture and Food Research

Efforts will continue to promote to the private sector programs run by the Alberta Agricultural Research Institute, as well as Alberta's agriculture and food research capability. The aim is to further expand the private sector's involvement in research, and encourage the practical application of research advanced by Alberta producers and processors.

Technology Infrastructure

Alberta Economic Development and Tourism will review the Technology Development Infrastructure Program. The department will refine its role and contribution for each sub-sector and niche to reflect the results of this assessment, as well as to support the overall research priorities of the government.

Forestry and Forest Products Research

Forest development research is aimed at increasing the value-added to Alberta's forest resources. By 1999, this is expected to result in an increase in employment to 1.4 jobs per thousand cubic metres of timber harvested.

Energy Research

Alberta Department of Energy will continue its 13 research programs in in-situ oil sands, oil sands mining and extraction, heavy oil, bitumen and heavy oil upgrading, conventional oil, enhanced oil recovery, natural gas, coal, hydrogen, renewable energy, minerals, transportation and marketing, and greenhouse gases. In addition, a program of research at universities will continue.

Environmental Research

Research programs will continue in environmental quality, land and forest sustainability, fish, wildlife and parks sustainability, and the partnership between Alberta Environmental Protection and Alberta Agriculture, Food and Rural Development.

Health Research

Alberta Health's business plan outlines two specific strategies: (1) develop and implement strategies and define, collect and provide data for performance reporting, decision making and population health monitoring; (2) support health services research, technology assessment and communication of findings from Alberta and elsewhere.

The Alberta Cancer Board's research business plan involves four key initiatives: (1) establish a $60 million cancer research endowment fund; (2) develop a $4.5 million gene therapy infrastructure program; (3) develop a provincial cancer clinical trials network; (4) recruit and retain high calibre cancer researchers.

The Alberta Heritage Foundation for Medical Research is committed to enabling the recruitment of 8 or 10 new people, and at least 60 trainees, and further developing health research and technology assessment. Projected expenditures for all programs are $32.8 million, a significant increase.

Alberta Research Council

Key strategies for the Alberta Research Council (ARC) are to (1) increase its mission effectiveness (wealth generated/grant investment) and the ratio of private sector R&D investments in targeted high-risk technology developments, (2) keep pace with Alberta's international competitors, and (3) generate wealth and jobs in the province. ARC's investment impact ratio is forecast to increase from about 5 in 1995/96 to 6 in 1996/97, and the ratio of private sector R&D investment to grant funding from about 0.8:1 to 1:1.

Transportation Research

Alberta Transportation and Utilities will continue its research program, some of which is undertaken jointly with other provincial and federal transportation departments, research agencies, and industry.

Table 1.1 Research & Development (R&D) Budget

$ Million

	1994/95	1995/96	1996/97	1997/98	1998/99
Alberta Advanced Education and Career Development[1]	0.06	0.02	0.02	0.02	0.02
Alberta Agriculture, Food and Rural Development	11.48	14.59	14.32	14.72	14.95
Alberta Agricultural Research Institute	6.46	6.16	5.61	5.41	5.30
Alberta Community Development	0	0	0	0	0
Alberta Education	0	0	0	0	0
Alberta Economic Development and Tourism	13.89	10.63	11.68	10.48	2.03
Alberta Energy	24.79	14.33	14.25	9.77	9.67
Alberta Environmental Protection[2]	11.13	10.34	8.11	7.63	6.89
Alberta Family and Social Services	0	0	0	0	0
Alberta Health	1.73	2.70	2.70	2.70	2.70
Alberta Cancer Board	2.80	2.80	2.80	2.80	2.80
Alberta Heritage Foundation for Medical Research	29.78	29.00	29.00	29.00	29.00
Alberta Research Council	22.55	20.32	18.90	18.90	18.90
Alberta Justice	0.36	0.32	0.32	0.32	0.32
Alberta Transportation and Utilities	0.78	0.63	0.63	0.63	0.63
Alberta Science and Research Authority	--	--	0	0	0
Total	**125.81**	**111.84**	**108.34**	**102.38**	**93.21**

[1]Advanced Education and Career Development provides $400 million in operating grants to universities each year. An estimated $159 million per year supports the cost of university research, either directly or indirectly.

[2]On July 10, 1996, the Government of Alberta approved the transfer of the Alberta Environmental Centre to the Alberta Research Council.

Table 1.2: Total S&T (R&D and RSA) Budgets

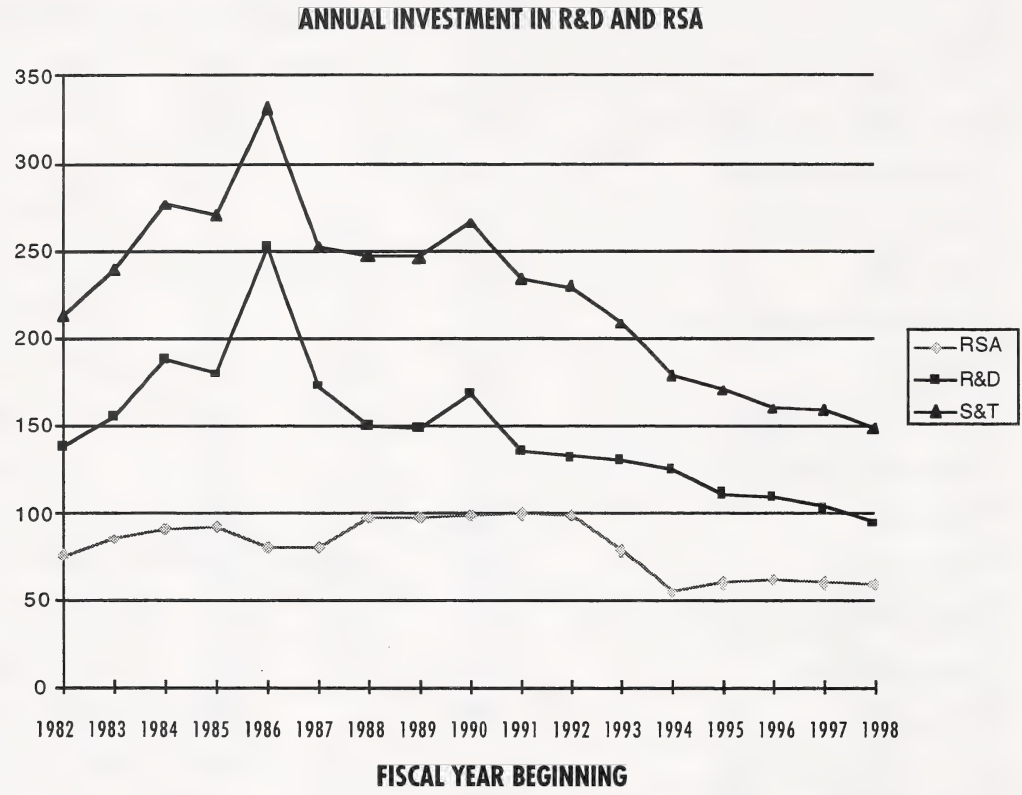
$ Million

	1994/95	1995/96	1996/97	1997/98	1998/99
Alberta Advanced Education and Career Development[1]	0.96	0.62	0.62	0.62	0.62
Alberta Agriculture, Food and Rural Development	20.07	24.73	24.09	25.01	25.73
Alberta Agricultural Research Institute	7.03	6.72	6.21	6.01	5.90
Alberta Community Development	14.33	14.33	7.9	7.9	7.9
Alberta Education	1.47	0.32	0.32	0.32	0.32
Alberta Economic Development and Tourism	14.53	11.12	12.30	12.25	4.75
Alberta Energy	26.51	20.04	21.31	22.48	23.38
Alberta Environmental Protection[2]	28.71	28.20	23.26	20.71	16.34
Alberta Family and Social Services	0.18	0.18	0.18	0.18	0.18
Alberta Health	3.60	4.68	4.68	4.68	4.68
Alberta Cancer Board	2.80	2.80	2.80	2.80	2.80
Alberta Heritage Foundation for Medical Research	29.78	29.00	29.00	29.00	29.00
Alberta Research Council	22.55	20.32	19.47	19.28	18.97
Alberta Justice	0.48	0.73	0.73	0.70	0.66
Alberta Transportation and Utilities	5.92	4.90	4.90	4.90	4.90
Alberta Science and Research Authority	-	1.50	1.50	1.50	1.50
Total	**178.92**	**170.19**	**159.27**	**158.34**	**147.63**

[1]Advanced Education and Career Development provides $400 million in operating grants to universities each year. An estimated $159 million per year supports the cost of university research, either directly or indirectly.

[2]On July 10, 1996, the Government of Alberta approved the transfer of the Alberta Environmental Centre to the Alberta Research Council.

Figure 1.1: Graph history of research budgets



2. 0 Introduction

2.1 Science and Research in Alberta

Research and development sustain and propel economic activity to higher levels by improving efficiencies, production and profitability. Science, research and technical innovation are critical components of economic growth and diversification.

Science and research also have an important impact on the lifestyles and well-being of Albertans. Economic growth stimulated by science and research has many social benefits including increased employment opportunities and improved social services. In addition, many significant advances in areas such as health and environmental protection are based on Alberta's long-term investment in science.

Sustained long-term investment in oil sands research, begun in 1921, has resulted in a $3.3 billion industry which pays more than $300 million in royalties to the provincial treasury.

Science and the technology flowing out of research have already had a significant impact on the development of the economy of the province and the overall welfare of Albertans. While Alberta has abundant natural resources, successful resource development has depended on technological advances to overcome significant barriers to development. For example: the short growing season in agriculture, the small, slow maturing trees in forestry, and the immobility of the hydrocarbons in the oil sands.

Alberta has trained and attracted innovative people who have supplied the necessary technological advances and scientific breakthroughs. Many regions of the world, with similar natural resources, lack the skilled agriculturists, seasoned geologists, leading reservoir engineers, advanced process engineers, innovative foresters, and world-leading medical scientists who live and work in Alberta.

Science and research are recognized as key to meeting today's economic and social challenges. They are vital for building an innovative economy and social structure for Albertans now and into the 21st century. If Alberta is to continue to realize the economic and social benefits of science and technology in the 1990s and beyond, increased government investment in science and research is required together with improved and integrated research management.

2.2 Report Overview

This report was prepared by Alberta Science and Research Authority (ASRA) and the Alberta Technology and Research Advisory Committee (TRAC). It is based on the departmental research business plans, as approved by the Government of Alberta in March, 1996. The report presents the research and development (R&D) and related scientific activities (RSA) plans, programs and proposed budgets for 1996/97 of the performing and funding government departments and agencies .

The report also includes some identified socio-economic impacts of the research programs and some of the knowledge and technology outputs that will produce socio-economic benefits. Performance measures for research and development, as in other areas, are being developed to help measure the effectiveness of the programs. Developing effective measures will need to examine not only the output and impacts but also the different inputs, the activities and the various types of outcomes of the effort.

The 1996-97 science and technology (S&T) proposed investment by the departments and agencies is $165.98 million, which is composed of $110 million identified for R&D and the remainder for related scientific activities such as technical surveys, library services for research, museum services and other related activities.

3.0 1995/96 Research Programs by Department or Agency

3.1 Alberta Advanced Education

Introduction

Research done at Alberta's universities plays a key role in meeting the strategic challenges facing the province today. Maintaining the scope and excellence of research within our universities is critical to Alberta's economy and quality of life.

- Research is vital to the learning experience of students. It prepares highly qualified graduates with the skills and know-how to meet the needs of the knowledge-based economy.
- Our universities are also proving to be major engines of economic development through the transfer of university-based technology and knowledge to the commercial sector.
- Research conducted at the universities provides the knowledge required to ensure the long-term viability of the province's major industries whether through the application of knowledge to natural resource industries such as energy, forestry or agriculture, in the emerging medical and biological fields, or in the high technology areas.

Each of the province's four universities occupies a unique niche in Alberta's adult learning system. The University of Alberta and the University of Calgary are research intensive universities that offer a comprehensive range of undergraduate and graduate programs. The University of Lethbridge is a smaller liberal arts university with a strong research component. Athabasca University specializes in distance education—its research relates primarily to distance delivery technology and pedagogy.

Alberta's universities are major performers of research and development funded directly through grants and contracts by the province ($31 million in 1994-95). The province also benefits from the research conducted at Alberta's universities funded by federal government sources (over $81 million in 1994-95).

Table 3.1: Alberta Advanced Education Research & Development (R&D) and Related Scientific Activities (RSA)

R & D	$14,000
RSA	$588,000

Strategic Research Objectives

- To lead and work with other partners to set new directions for adult learning, and to provide Albertans with an accessible, responsive, and affordable system of quality adult learning that is accountable for results.
- Provide operating grants to universities to enable the universities to provide the teaching and research facilities and staff required.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

The University of Alberta is in the top five Canadian universities in total research funding — $94.5 million in 1994-95. Since 1988-89, the University of Alberta has received more than $565 million for research from external sources. Over the past two years, this funding has increased by 17%. There are 43 active University of Alberta spin-off companies. They have created over 850 direct jobs and approximately 1,600 indirect jobs.

Open for business

Alberta universities are opening their doors to private sector. They are moving quickly to commercialize university technologies and capitalize on our world-class research programs.

The University of Calgary's technology transfer subsidiary, University Technologies International Inc. (UTI), has licensed more than 250 technologies since its inception in 1989. Gross revenues from licensing and sales is nearing $3 million annually. That puts UTI in the big leagues, according to a survey done by the Association of University Technology Managers, which ranked technology transfer institutions in North America by licence and patent royalties received. In 1996, UTI climbed into second place in Canada, behind the University of Waterloo.

There's also been growth at the University of Alberta. During the past year, royalties from commercialization of university technologies brought close to $1 million to the University. As well, 17 new spin-off companies have been created over the past two years.

One of the spin-offs, Isotechnika Inc., is making a name for itself in organic compound analysis with its ability to "fingerprint" virtually any organic, and many non-organic substances. Using its proprietary tools and protocols, the company can differentiate between seemingly identical substances and determine their origin. These patented technologies were developed by Drs. Robert Foster and Richard Lewanczuk at the University of Alberta.

The University of Calgary is recognized by national and international bodies for the excellence of its research. Total research funding for 1994-95 was $63.9 million, with $21.3 million from the private sector. University of Calgary initiatives will create more than 600 new jobs in 1996, including 220 from new ventures started by or with the help of faculty. Applying the standard multiplier of 1.7, University of Calgary research will create more than 1,000 new jobs in 1996, mainly in and around Calgary.

In 1994-95, the University of Lethbridge brought in excess of

$2.1 million in external funding for research. While predominantly an undergraduate university, the University of Lethbridge prides itself on the high quality of not just its teaching but its research as well — research that uniquely involves undergraduate students. The University's research programs provide significant benefits to the community and are a convincing example of the strength of partnerships with local and federal agencies.

1996/97 Plan

An estimated $400 million per year will be provided as an operations grant for the universities. Approximately $160 million of this will support university research, either directly or indirectly.

The focus of R&D and RSA activities in the Department will be:

- Analysis of labour market statistics.
- Analysis of demographic trends.
- Support for the development of computer based training material.
- Policy studies.

Beginning in the 1996/97 fiscal year, an additional $2 million per year will be specifically targeted over the next three years for university research excellence. The funding is intended to stimulate financial contributions from the universities and their partners toward the cost of recruitment of new faculty.

In early 1996, the department engaged Dr. Gilles Cloutier to recommend to the Minister a policy framework for university research. Dr. Cloutier undertook an intensive consultation with the universities and knowledgeable stakeholders, and provided his recommendations to the Minister in June of 1996. His report provided a good starting point for the department in developing its policy framework for university research.

Winning ways

Dr. John Wallace, a University of Calgary professor, was named the 1995 recipient of the prestigious Michael Smith Award of Excellence for his work in developing a new aspirin replacement that avoids that drugs' side effects.

Wallace won the award for his work in the gastrointestinal field, including the development of a new form of non-steroidal anti-inflammatory drug (NSAID), which appears to avoid the problems of stomach ulcers and bleeding common to existing NSAIDs. The drug's development has received $10 million in support from Apax, a European venture capital company.

3.2 Alberta Agriculture Food and Rural Development

With more than 51 million acres in crop and livestock production, Alberta has developed one of the world's most productive agriculture and food industries. The quality of our products are internationally acclaimed. From lean beef, high protein wheat and nutritionally superior canola oil to choice pork and the finest potatoes, Alberta farm products have set global standards of excellence.

In 1995, the agriculture and food industry contributions to economic activity grew to over $11 billion from about $10 billion in 1994. Alberta's total farm cash receipts increased from $4.2 billion in 1991 to $5.8 billion in 1995.

The industry is globally competitive, exporting to 138 countries. Exports in 1995 totalled a record $4.1 billion, 16% higher than the previous record achieved in 1994. The industry employed 113,400 Albertans in 1995 and had the lowest unemployment rate among the major industries in the province at 1.6%.

Alberta Agriculture Food and Rural Development runs four major research programs: crop development, livestock development, processing development and environmental stewardship.

Table 3.2: Research Program Budget
Alberta Agriculture, Food and Rural Development Research & Development (R&D) and Related Scientific Activities (RSA)

($'000)

Research Program Area	R&D 96/97	RSA 96/97	96/97 Budget Projection Total	R&D 97/98	RSA 97/98	97/98 Budget Projection Total	R&D 98/99	RSA 98/99	98/99 Budget Projection Total
CROPS	$6,783	$2,881	$9,664	$6,843	$3,087	$9,930	$6,861	$3,227	$10,088
LIVESTOCK	2,329	2,755	5,084	2,600	2,892	5,582	2,796	3,237	6,033
PROCESSING	2,017	2,012	4,029	1,913	2,000	3,913	1,923	2,015	3,938
ENVIRONMENTAL STEWARDSHIP	3,189	2,125	5,314	3,362	2,227	5,589	3,376	2,297	5,673
Total	$14,318	$9,773	$24,091	$14,718	$10,296	$25,014	$14,956	$10,776	$25,732

3.2.1 Crop Development Program

Introduction

Crop production is an important component of Alberta's agricultural sector. Alberta producers grow more than 30 different crops, ranging from cereals to vegetables. Farm cash receipts for crops in 1994 were estimated at $2.15 billion. Total value of all crop production (including forages and farm consumed feed stuffs) exceeded $3 billion.

Farm cash receipts for crops increased by 40% in 1994, over the 1993 total of $1.5 billion. Canola receipts alone increased by $379.4 million, from $412.7 million in 1993 to $792.1 million in 1994. This one year increase in the value of canola was more than sufficient to pay for all the money spent on canola research in Canada over the last 40 years. Alberta is the second largest producer of canola and wheat and the leading producer of such other crops as barley, sugar beets, forage and grass seed, hay and clover. Research and technical advances help the industry to remain competitive in domestic and international markets. By improving product quality, reducing unit costs through efficiency, or creating novel products, research enables the industry to retain existing markets, penetrate new markets, increase global market shares and sustain opportunities for growth.

Strategic Research Objectives

Crop research is aimed at generating new information, developing new varieties, testing crop diversification options and investigating new technology that improves the efficiency of crop production. The improvements may be in yield, quality, economic returns or sustainability. Research and technical advances help our crop sector to remain globally competitive, financially profitable and environmentally sustainable. Crop research also generates information useful for conducting crop-related regulatory functions.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- Alberta researchers have identified copper deficiency as a main cause of depressed cereal yields on several million acres of crop land across Alberta. Application of copper-enriched fertilizer to copper-deficient soils can result in yield increases of 100% or more. The potential return on the investment in the research project may total over $315 million per year.

- Ten varieties of barley, two new spring triticales and one winter triticale were developed and released for commercial production. One new

barley variety has high potential as an animal feed and is also creating interest in Asia for its human food value. Because the digestibility of this variety is higher than other sources, the level of nitrogen in livestock wastes is lower, which reduces the environmental impact of the wastes.

New varieties of winter triticale and new lines of winter wheat are more drought hardy and cold tolerant. The economic benefit of these developments is estimated at over $100 million in 1996.

- New agronomic procedures for forage production under irrigated conditions have allowed the industry to use previously unproductive land, and expand from approximately 1000 acres to over 8,000 acres. Evaluation of forage quality using near infrared spectroscopy will result in reduced costs and increased precision in selection of appropriate forage for animal feed. Correct selection of forage can reduce feed costs by 1%, saving approximately $3.8 million throughout Alberta every year.

- More efficient and diverse production of tree seedlings for commercial farmers, nursery growers and shelterbelt contractors is resulting in more productive and longer-lived farm and field shelterbelts. Shelterbelts contribute to soil conservation, crop protection, moisture retention, wildlife habitat and beautification of the prairie landscape.

- New agronomic information has helped improve the quality and yield of horticultural crops. Tissue culture techniques were developed for the propagation of saskatoons, roses and seed potatoes, and transferred to commercial operations throughout the province. Recommendations were developed for long term storage of horticultural crops. Biological pest control recommendations were developed for the greenhouse industry. Cash receipts from floriculture and the nursery industry increased 4% in 1994 to $64 million. This growth is expected to continue.

- As a result of screening and selection of improved cultivars of special crops such as peas, lentils, dry beans and mustard, these crops are now widely grown in the province. A range of herbs, spices, specialty grains and essential oils were evaluated for adaptability to Alberta conditions. Cash receipts from specialty crops totalled $286 million in 1994, a 14% increase from 1993. Production of field peas has increased dramatically. Annual sales increased from $2.6 million in 1984 to over $44 million in 1994.

1996/97 Plan

The crop development research program will focus on:

- Providing scientific information to producers and processors. This new knowledge will lead to new market development, increased crop production efficiency, and better crop quality.
- Increasing diversification of the crop and crop product base in Alberta. The department expects to develop, on average, one new crop variety every year.
- Improving the productivity and sustainability of Alberta's soil and crop resource base to keep the industry globally competitive.
- Undertaking efficient marketing efforts in priority markets to improve Alberta's market share of products derived from crops.

3.2.2 Livestock Development Program

Introduction

Livestock production is a leading component of Alberta's agricultural sector. Market receipts for livestock sales were approximately $2.94 billion in 1994. Each segment of the livestock industry contributes millions of dollars annually to the provincial economy. For example in 1994, farm cash receipts for cattle and calves were $2.12 billion; swine, $330.5 million; dairy products, $260.9 million; poultry, $112.2 million; and sheep and lambs, $13 million.

Alberta is the largest beef cattle producing province in Canada, and the fifth largest beef cattle producing jurisdiction in North America. Our province accounts for 63% of Canada's total fed cattle production. Alberta's beef cattle industry is a market-driven, globally competitive sector. In 1994, the value of Alberta beef exports totaled $385.9 million, approximately 32% higher than in 1993.

Expanding markets for livestock and livestock products can be expected to create continued growth and expansion of the industry. Research and technology have made substantial contributions to the improvement of livestock productivity and to the diversification of the industry.

Strategic Research Objectives

The livestock research program is aimed at generating information and technologies that help increase output per animal, improve product safety and quality, reduce production costs and improve economic returns. Livestock related research projects include animal nutrition studies, animal health and productivity, animal breeding and management, and work relating to the diversification of the livestock industry into the production of species such as bison, elk, llamas and alpacas.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- New methods of minimizing production costs in beef and sheep by providing alternative management strategies including the use of herd management computer software, alternate feed crops for feedlot cattle, alternate castration methods, and methods to predict diseases such as dystocia in beef cattle. Increased efficiencies will help maintain the competitiveness of this $3 billion dollar industry.

- Increasing production efficiency by better understanding the effects of water quality on livestock production and optimizing reproduction efficiency by minimizing calving difficulty. Reduction in losses due to diseases and mortality will continue to increase the productivity of this industry.

- Bison and elk handling guidelines for the safe and efficient handling of stock that minimizes stress or injury to the animals. This information will help the 200 bison producers and 250 elk producers in this emerging industry.

1996/97 Plan

The livestock research program over the 1996-99 planning period will focus on:

- New approaches for treating clinical mastitis in dairy cattle.
- Prediction of amino acid content for cereals and protein supplements used in swine rations.
- Effect of nutrient dilution on broiler breeders in poultry.
- Benefits of an electronic birth-to-slaughter information system for beef cattle.
- Value-added animal products.
- Diversified livestock production.
- Stewardship and animal welfare issues.
- Improving Alberta's market share of products derived from livestock in priority markets.

3.2.3 Processing Development Program

Introduction

Processing and packaging represent the final stages of agricultural production before finished products are delivered to the consumer. Alberta's agricultural processing industry is an important and growing sector of the economy.

There are over 350 companies in Alberta that process agricultural products. The annual value of shipments from these companies was estimated at $5.6 billion in 1994. With the expansion of value-added processing, shipments are expected to increase to $20 billion over the next 15 years.

Meat processing is the largest component of the industry and Alberta is the leading processor of beef in Canada, accounting for over 55% of the nation's beef production. Beef processing companies in Alberta have already announced plans to double beef output in the next three to five years. As well, Alberta is among the top processors of canola oil, malting barley, processed forage, mustard and honey in the country. The food and beverage industry has grown to $5.6 billion in 1994 and has tremendous potential for further growth.

Strategic Research Objectives

The central aim of the department's research effort in processing is to develop or transfer technical information that will facilitate the growth of the processing industry. Through efficient marketing efforts, the department will improve Alberta's market share of processed agri-food products in priority markets.

Research includes the generation of scientific information, new product development, new food packaging techniques, assessment of new technologies for shelf-life extension, quality control techniques and food safety improvement. Research projects involve: 1) functional foods, 2) high value ingredients from cereals, 3) meat by-products, and 4) dairy products

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- New technologies, such as Modified Atmosphere Packaging and Batter/Breading Processing of Meat products, have been adopted by industry. They have resulted in new products on the market and have led to company growth.

  For example, modified atmosphere packaging has increased the shelf life of pre-packaged sandwiches from approximately 10 days to 35 days. As a result, the industry can now supply sandwiches nationally rather than just locally.

- Other new technologies such as Ultrafiltration and Extrusion Cooking are still being tested. They could generate new lines of products and further value-added growth in the food and beverage industry.

- Hazard analysis, quality assurance methods, and industry adoption of manufacturing practices have resulted in increased safety of the food supply.

1996/97 Plan

Over the course of the three year business plan, the investigation of two new technologies and five joint research projects relating to value added processing will be completed.

3.2.4 Environmental Stewardship (Soil and Water) Program

Introduction

Soil and water resources are the foundation of Alberta's agriculture and food industry. Farmers use 51.4 million acres of land to support crop and livestock production. About 3 million acre-feet of water are diverted each year for irrigation of 1.5 million acres of agricultural land. Consequently, environmental stewardship is an essential component of sustainable development in the agri-food industry. Wise soil and water management will prevent the degradation of these resources and ensure the long-term economic and environmental viability of the agri-food industry.

Strategic Research Objectives

This program's goal is to develop information, practices and technologies to help a growing and globally competitive agri-food industry sustain the natural resources it depends on. The program currently focuses on three main aspects of the environment: soil quality, water quality and water use efficiency.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- An accurate information base on conservation cropping has encouraged widespread adoption of erosion control practices such as reduced tillage and continuous cropping. Reduced erosion will help to maintain the sustainability of the industry.

- More efficient fertilizer management and an automated salinity monitoring system (which measures soil salinity faster and more accurately) provide better salinity control. This can save millions of dollars per year in fertilizer costs without reduction in yield.

- A survey of 200 farmstead wells and dugouts has resulted in baseline information on water quality and water user information. It is serving as a pilot for a more comprehensive assessment of farmstead water quality.
- A revised code of practice for handling livestock manure will protect water systems from manure contamination.
- An information base is prompting the industry to increase its activities in protecting water quality.

Weed-eating fish clean up Alberta's irrigation canals

Alberta farmers have a new way to tackle an old weed problem. Almost since irrigation began in Alberta in the early 1900s, growth of aquatic plants in canals has impeded water flow. The result has been a serious shortage of water —sometimes as much as 80% less flow—during critical growing periods for crops. Now, scientists have found a potential solution: a species of fish with a voracious appetite for weeds.

A five-year study showed that sterile grass carp are an effective and environmentally friendly method of weed control in Alberta's irrigation canals. The fish removed huge quantities of aquatic vegetation from weed-infested test sections of irrigation canals. An added benefit is the reduced need for chemical herbicides, the common method of weed control.

- Successful spawning of grass carp (fish that eat aquatic weeds) has led to a biological alternative to chemical weed control in irrigation canals and dugouts.
- Increased farm irrigation efficiency through better sprinkler systems, improved soil moisture management and better operational management has helped reduce water requirements and water loss in irrigation canals.
- Alternative energy systems such as wind turbines, photovoltaics and deep well pumping systems were evaluated and demonstrated.

1996/97 Plan

The program will develop information, practices and technologies to allow the industry to maintain and enhance the natural resources it depends on, and to retain access to the technologies and management practices that make it globally competitive.

The program will follow five basic steps:

- Assess the current situation relating to environmental impacts.
- Determine the causes of any impacts.
- Develop/adapt best management practices to address the causes.
- Encourage the agri-food industry to adopt these practices.
- Assess the new situation to determine the effects of practice change.

3.3 Alberta Agricultural Research Institute

Introduction

The agriculture and food industry is one of Alberta's economic strengths. It supplies high quality food products for Albertans, creates employment and generates wealth. The industry makes substantial contributions to the prosperity and well-being of Albertans.

Research, innovation and technology development are important for future growth of the industry. The Alberta Agricultural Research Institute (ARI) coordinates and supports research to promote growth of the industry and increase its contribution to the province's prosperity.

Strategic Research Objectives

ARI's strategic research direction is to: (1) strengthen the agriculture and food research network in Alberta through coordination, and (2) fund agriculture and food research with the greatest potential benefit to Albertans, in partnership with the private and public sectors.

In 1995/96, these strategies were implemented through 10 programs, ranging from Matching and Direct Funding programs, which support research projects, to On-Farm Demonstration and Scientific Conference Funding programs, which enhance the transfer and application of research results by industry.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

The projects supported by ARI have generated many valuable results in four key technology areas: crop production, livestock production, agri-food processing, and soil and water management.

Crop Production Technology

Results from this program include:

- New soft wheat and canola varieties.
- Improved crop management systems for dryland areas.
- Irrigated barley, wheat and canola production.
- Biological control of weeds.
- Management of new field pea varieties.
- Production of alternative crops.
- High-yielding combinations of alfalfa and bromegrass for hay and pasture.

These results played a strong part in the improvement of crop yields and the further diversification of crops in the province. For example, an economic analysis of the impact of the investment in developing new wheat varieties predicted a return of over $38 to the provincial economy for every dollar invested. The impact is already clear in the steady increase in farm cash receipts generated by the crop sales. Receipts increased from $1.3 billion in 1987 to $1.6 billion in 1990 and $2.5 billion in 1995.

Livestock Production Technology

Projects supported include:

- New approaches for enhancing the immune systems of cattle.
- The impact of feed variability in cattle and sheep nutrition.
- Application of ultrasound techniques to assess carcass composition in live cattle.
- New approaches for livestock disease control.
- Improved livestock management techniques, including innovative watering and feeding systems.

An economic evaluation of the ruminant nutrition research results showed a return of $30 to the provincial economy for every dollar invested. A similar evaluation of swine disease control research results recorded a return of $29 to the provincial economy for every dollar invested.

These results, along with the work supported in the department, private sector and other organizations, have contributed to the growth of a highly productive livestock industry in the province. Livestock sales, particularly beef cattle, have grown steadily over the last five years. Receipts for livestock and livestock products increased from $2.2 billion in 1991 to $3.0 billion in 1995. Alberta is now the national leader in beef production and the fifth largest producer in North America. Our market share is expected to grow much higher when the expansion of the beef processing capacity, currently underway, is completed by the turn of the century.

Agricultural Processing Technology

Research supported includes:

- Gas Packaging Techniques to extend the shelf life of bakery products.
- Development of a new Ultra High Temperature (UHT) whipping cream product with an extended shelf life.

- A new method to genetically engineer canola for higher value enzymes and pharmaceutical products.
- New high value biological materials from packing plant by-products using a supercritical fluids extraction method.
- New techniques to increase the shelf life of pork.

Canola power

It's tempting to attribute canola's popularity to high prices and increasing consumer demand. But markets don't tell the whole story. In fact, markets for canola would never have existed if not for the science that went into the development of this crop.

And the canola research effort continues... A new technology pioneered in Alberta allows canola plants to be used as "factories" for the manufacture of proteins and enzymes that can be made into drugs, industrial chemicals and agricultural products.

It's been known for some time that plants can be genetically engineered to produce almost any protein or enzyme. The stumbling block comes in trying to purify the desired substances. This problem was solved by Dr. Maurice Moloney, a University of Calgary biological sciences professor, and his research team. A new company, SemBioSys Genetics Inc., is commercializing the technology.

Early results are promising. SemBioSys has introduced genes to canola plants which produce interleukin in canola seeds. This protein is used to combat infections and some forms of cancer. The team has also produced a canola seed that contains a blood anticoagulant. The substance is now in clinical trials.

A number of the technologies developed through ARI support are already being used by industry. For example, the shelf life extension technology for bakery products is now used by an Alberta company, helping to increase its market share, level of output and employment. An economic analysis of the benefits of this technology conducted for ARI showed a return of $70 to the provincial economy for every dollar invested in testing the technology.

Industry performance is an important measure of the benefits derived from research. The application of research results, new knowledge and technology is fueling growth in Alberta's food and beverage industry. The annual value of shipments from the industry is rising steadily, from $4.5 billion in 1988 to $5.9 billion in 1995. It is expected to reach $20 billion by 2005.

Soil and Water Management Technology

Project highlights include:

- Effectiveness of various animal and green manures for the reclamation of eroded soils.
- Elimination of aquatic vegetation in irrigation canals and dugouts using triploid grass carp (a grass eating fish).
- New recommendations for soil compaction problems caused by field equipment on crop land.

- Control of dryland salinity using alfalfa and salt-tolerant grasses.
- Comparison of solar energy powered water pumping and wind powered pumping for cattle watering systems.
- Comparison of different seed placement techniques, indirect and minimum till systems.

These results are useful for improving current crop production and maintaining or enhancing the productivity of the Alberta's 51 million acres of farmland.

One significant achievement in the application of research results to soil management is the reduction of summerfallow in soils prone to salinity build-up. Summerfallow can increase soil salinity in certain soil zones across the prairies. Alberta farmers are now applying the results of salinity research through the use of salinity reducing practices such as zero tillage, minimum tillage and the inclusion of legumes in crop rotation. The annual acreage under summerfallow has been reduced by 30% between 1986 and 1995. At the same time, acreage under such soil building crops as alfalfa, peas, beans and lentils has increased substantially.

1996/97 Plan

ARI's business plan emphasizes funding projects through matching grants, while making provisions for direct funding of research projects that are in the public interest. Administrative costs will be further reduced and operations will continue to be streamlined and adjusted. The Research Professorship Program and the Scientific Conference Assistance Program will be discontinued in 1996/97. Funding under the National Agricultural Biotechnology Initiative (NABI) will continue to be managed as part of the Matching Grants Program until projects already approved are completed.

Efforts will continue to promote ARI programs, as well as Alberta's agriculture and food research capabilities, to the private sector. The aim is to further expand the private sector's involvement in research, and encourage the practical application of research advances by Alberta producers and processors.

3.4 Alberta Community Development

Introduction

Alberta has a great wealth of human and natural history. Our physical resource base includes countless artifacts, specimens, documents, structures and sites that are authentic and tangible evidence of our past and the natural and cultural landscapes of this province.

The resource base is threatened by pressures ranging from natural aging and weathering to competitive land development. Traditionally, heritage resource conservation and development initiatives around the world have been largely a publicly demanded and funded effort, seen as part of the maintenance and education of a healthy society.

In Alberta, the responsibility for resource management rests in large part with the Province. The Government of Canada's activities in the heritage resources area in Alberta are primarily confined to regulation of the export of Canadian cultural property, the operation of two national historic parks, and some limited cost sharing to develop other heritage attractions of national significance within Alberta. Municipal involvement in heritage and community participation has grown strongly in recent years, as has private sector restoration of historical buildings.

Table 3.3: Alberta Community Development

Community Development Related Scientific Activities Projected GRF Budget

$million

	1996/97	1997/98	1998/99
Historical Facility Management	7.9	7.9	7.9

Strategic Objectives

- To operate provincial heritage facilities, and conduct resource preservation and management.
- To provide exhibits that will attract and teach visitors, preserve artifacts that are important to Alberta's history, and work with communities to assist them in taking responsibility for their own heritage resources.

1995/96 Highlights— Technology Accomplishments and Socio-Economic Benefits

Alberta has developed a number of historical attractions, some with international appeal and significance such as the Royal Tyrrell Museum of Paleontology and Head-Smashed-In Buffalo Jump. This network of attractions continues to grow, and with associated interpretive services, provides an important dimension to visitor activities.

Alberta's provincially owned heritage facilities alone attract approximately 1.1 million visitors annually and generate some $55 million in provincial economic activity. In total, Alberta's museums receive 6.7 million visitors annually.

1996/97 Plan

To provide established services with respect to heritage facilities and related programs, through increasing external partnerships with other agencies, the private sector, community groups and the public.

3.5 Alberta Economic Development and Tourism

Building on an impressive foundation of energy, agriculture, forest resources and tourism, Alberta continues to add new dimensions to its economic picture—in manufacturing and process industries, in the advanced technology and service sectors, and in a host of trading relationships that have already made Alberta a familiar name in many parts of the world.

The size of the Alberta economy nearly doubled from 1974 to 1995. As well, Alberta's international exports grew to $29 billion in 1995 and accounted for 34% of the province's GDP.

The mission of Alberta Economic Development and Tourism is to define and advocate favorable regulatory and tax conditions for investment in the province, assist Alberta businesses to be globally competitive, and provide information, coordination and analytical support to enhance global marketing efforts. The applied research and technology development activities supported by the department contribute to this mission by developing new technologies, developing knowledge and understanding of the potential applications of enabling technologies, and identifying and communicating the conditions necessary to accelerate development and commercialization of these technologies.

The department supports five major programs: the Technology Development Infrastructure Program, Forestry Research and Development Program, Economic Policy and Statistics Program, Independent Business Development Program, and the Tourism Development Program.

Table 3.4: Alberta Economic Development and Tourism

Research and Development Programs ($ Thousands)

R&D Programs	1995/96	1996/97	1997/98	1998/99
Technology Development Infrastructure Program	9,825	10,875	9,925	1,820
Forestry Research and Development Program	800	800	550	210
Total	10,625	11,675	10,475	2,030

RSA Programs				
Economic Policy and Statistics Program	150	150	150	150
Independent Business Development Program	35	40	40	40
Tourism Development Program	305	278	200	200
Total	490	468	390	390
TOTAL	11,115	12,143	10,865	2,420

[1] This total includes $7.5 million as an extension of the WESTAIM initiative.

[2] The Alberta/Canada government partnership with Sherritt Inc. on the WESTAIM initiative will have been completed.

3.5.1 Technology Development Infrastructure Program

Introduction

Alberta's technology development infrastructure initiatives stimulate leading-edge applied research in the province. They develop and retain world-class scientists and engineers, develop strong university/industry/government partnerships and accelerate the diffusion of technology into industry. The result is new commercial enterprises in Alberta, job creation and increased local and international investment.

Strategic Research Objectives

The infrastructure development initiatives of the Technology Development Branch are designed to work closely with industry and universities, building on Alberta's strengths in advanced technology. This group of initiatives supports the department's core businesses in investment, industry development and the creation of a competitive business climate. They stimulate leading-edge applied research in Alberta, accelerate the development and diffusion of new technology into Alberta industry, attract investment and create jobs.

The five elements of the program are: the Alberta Microelectronic Centre, Telecommunication Research Labs, the Laser Institute, the Western Advanced Industrial Materials Initiative (Westaim), and the Networks of Centres of Excellence Program.

Alberta Microelectronic Centre (AMC)

AMC assists Alberta industry in the application of microelectronic technology by providing consulting and feasibility studies, microelectronic prototype development, technology assessment, Application Specific Integrated Circuit (ASIC) design/fabrication, sensor research and development and prototyping. Its objectives are:

- Increase education and awareness of microelectronics by acting as a catalyst to facilitate development of skills in industry and in educational institutions.
- Provide product development/consulting services to assist regional companies in using microelectronic technologies.
- Provide support to government to assist with technology transfer and other electronics initiatives in Alberta.
- Support research and development in microelectronics.
- Seek commercialization opportunities for the Centre's skills and resources.

Microelectronic technology gives Grande Prairie manufacturer an international edge

What a difference technology makes. In 1988, Grande Prairie's Risley Equipment Ltd. was a small machine shop employing about 45 people. In 1996, the company is an international manufacturer employing more than 200 people and exporting millions of dollars worth of Alberta-manufactured equipment to markets in North America, Europe and Japan.

One of the keys to Risley's success is its continuing relationship with the Alberta Microelectronic Centre. AMC helped Risley adapt microelectronics technology for use in the forestry equipment it manufactures. The technology has given Risley a unique and marketable capability, and helped transform the company into one of North America's largest forestry equipment suppliers.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- Revenue more than doubled in three years to $8 million in 1994/95.
- An estimated 1000 jobs have been created over the past few years and $900,000 annually in tax revenue to Alberta from direct and indirect jobs.
- Training value to industry and universities was estimated at almost $1.5 million in 1993.
- A 37% increase in microelectronics product shipments from Alberta for 1994 relative to 1993 (5% of Alberta's manufacturing shipments).
- Fiscal year funding leverage was 1.7 times Alberta's contribution.

Telecommunication Research Labs (TRLabs)

TRLabs is the largest, collaborative, non-profit telecommunications research initiative in Canada. It involves industry, university and government in research on telecommunications networks and system photonics, wireless technologies and data networking and related software. The business of TRLabs is to deliver leading-edge people and technologies to fuel the growth of its sponsors. Its objectives are:

- Provide a synergistic environment where industry and academic researchers can work together.
- Attract, develop and deliver a continuous stream of quality telecommunications research people for the benefit of sponsors and industry.
- Execute a telecommunications research program, appropriate to staff and sponsors, that produces meaningful results.
- Maintain and broaden the base of sponsors to include additional sponsors from regional, national and multinational corporations, Canadian universities, and provincial and federal governments.
- Build a network of telecommunications research organizations based on industry, university and government collaboration.

Making a name in telecommunications research

What started out 10 years ago as an Alberta "experiment" has turned into Canada's leading telecommunications research consortium.

TRLabs is one of the nation's most respected and successful examples of industry, university and government collaboration. Over 180 people work at its five locations across western Canada. Well over 100 students have obtained their Master's or Ph.D. degrees through the research program.

TRLabs was a vision of its founding sponsors: Nortel, the University of Alberta and the Government of Alberta. They wanted to set up an innovative research network that would provide opportunities for economic development. Today, 36 partners comprise the TRLabs network including small businesses, multinational corporations, western Canadian universities and the governments of Canada and the prairie provinces.

- Expand the contribution of the telecommunications industry to the economic base.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- 1995 revenue growth of 20%.
- 56 technology applications developed in 1995.
- 1995 leverage of 5.9 on Alberta's 17% share of costs.
- Won 1995 national award from the Conference Board of Canada and National Sciences and Engineering Research Council as the best university/industry R&D partnership.
- 19 industry secondments and 20 graduates placed in Alberta businesses.
- 2 spin-off companies created, an estimated $1 million revenue from one of these companies.
- 12 patents awarded, 3 patents pending, over 300 scientific publications.
- Organized 10 international conferences in Alberta, generating an estimated $3 million in expenditures in Alberta.

The Laser Institute (TLI)

TLI assists industry by undertaking core and contract research, and providing a range of laser technology services. Its primary objectives are:

- Assist in the development of new laser-related products and applications involving lasers and associated high technology.
- Provide laser-based business services to industry.
- Transfer laser technology to industry through services, facilities and direct assistance to industry.

International demand for Alberta-made laser cutting systems

For specialized laser cutting expertise and hardware, Alberta is the place. Alberta's The Laser Institute (TLI) has become internationally known for its laser system that can cut intricate patterns into cylindrical products. No other company in Canada, and very few companies in the world, make systems for this application.

The result? Direct export orders for TLI's high value-added products. While the company has already exported services indirectly (embedded in the products of many Alberta companies), TLI is now winning direct export contracts – an important milestone.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- Development and provision of advanced laser cutting services to Alberta companies, enabling them to compete with large corporations from major technology centres.
- Successfully entering the US market with laser cutting technology and services.
- Fiscal year funding leverage was 2.5 times Alberta's contribution (based on average 1992 fiscal year funding).
- 1995/96 direct exports of approximately $1 million.
- Several million dollars in benefit to three Alberta companies. Through expenditure of $25,000, one company was able to generate 6% of its total 1995 sales.

Western Advanced Industrial Materials Initiative (Westaim)

The Westaim Initiative was undertaken to develop research capability in advanced materials, and develop and commercialize advanced materials technologies. The Westaim Corporation, a wholly owned subsidiary of Viridian Inc., will now continue this work. The Westaim Initiative has involved or contributed to:

- Research, development and commercialization of advanced industrial materials and related products and processes.
- Economic diversification in western Canada and particularly in Alberta.
- Expanded research and development capability for advanced industrial materials in western Canada and particularly in Alberta.
- Development of qualified technical and professional personnel in advanced industrial materials.
- Development of industrial, academic and research alliances in advanced industrial materials.
- Establishment of long-term advanced industrial material research and development capabilities in Alberta.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

To date, six major projects have advanced to commercial or pre-commercial consideration through a disciplined "gating" process that assesses market, technical and commercialization aspects. They are:

- antimicrobial coatings for biomedical applications

- electroluminescent flat-panel displays that provide superior image quality and greater operational tolerances
- aluminum nitride substrates for electronics
- silicon nitride ceramic cutting tools
- coking-resistant coatings and related coating-application technology, and
- nickel and cobalt-based battery materials.

Networks of Centres of Excellence Program (NCE)

The Networks of Centres of Excellence Program was established to create networks of leading-edge scientists from industry, universities and government. Consistent with the economic priorities of the Government of Alberta, it has been a model effort to leverage increased industry support for commercially relevant research. The program's objectives are:

- Stimulate leading-edge fundamental and applied research.
- Develop and retain world-class scientists and engineers.
- Develop strong university-industry partnerships.
- Accelerate the diffusion of technology to industry.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- 13 invention disclosures to the Industry Liaison Office (U of A), with 4 inventions either licensed or in the process of being licensed (3 in Alberta, 2 of these as new spin-off companies).
- 6 patent applications, 2 copyright-protected inventions and 1 trademark-protected invention.

1996/97 Plan

During 1996/97, the Technology Development Infrastructure Program will be reviewed to ensure that the future development and application of strategic technologies will continue to provide maximum support to Alberta's economic growth.

Each technology sector, sub-sector and niche is being reassessed in detail, considering its state of development and the role and contribution of its other stakeholders. This assessment will review each stage of the progression in innovation from new discoveries in basic science to the production and sale of innovative commercial products and services. Alberta Economic Development and Tourism will refine its role and contribution for each sub-sector and niche to reflect the results of this assessment, as well as to support the overall research priorities of the government.

3.5.2 Forestry Research Development Program

Introduction

Forestry is Alberta's fourth largest primary economic sector with shipments of $3.5 billion in 1994 and exports of approximately $1.9 billion.

Nearly $4 billion in new investment has occurred in the forest products sector since 1986. As a result, Alberta has dramatically increased its production of pulp, newsprint, oriented strandboard and medium density fibreboard. The sector has 20,000 direct jobs and provides 30,000 indirect jobs.

Forestry projects currently under construction total $400 million. It is estimated that another $3-4 billion in new forestry-related investment could be initiated over the next four to five years. Forestry research and development will play an important role in achieving these investment objectives and addressing a number of key technical, environmental and marketing issues facing the industry.

Strategic Research Objectives

The Forestry Research and Development Program is intended to support research projects in partnership with industry. The focus is on projects that have commercial application with respect to materials, products, processes, devices, systems, methods, designs, standards and services.

The objectives of the program are:

- Improve competitiveness of the forest products sector in domestic and global markets.
- Improve recovery and utilization of small diameter timber and develop engineered and value-added products based on Alberta's mix of wood species.
- Utilize mill and harvesting residues as furnish for added-value products.
- Assist in regulatory approvals and standards development for Alberta forest products in domestic and export markets.
- Develop new technology and products that utilize composites and agri-fibres in combination with wood fibre.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- Growth of the oriented strandboard and chemithermomechanical pulp industry in Alberta has led to a $300 million investment and the creation of approximately 500 jobs.
- The Wood Composite Laboratory at Alberta Research Council (ARC) is at the leading edge of the technology and recognized as a world-wide leader in wood composite research.
- The ARC Pulp and Paper Laboratory supports the young Alberta mechanical pulp industry. It has shown outstanding results in the utilization of chemithermomechanical sludge as a soil conditioner and fertilizer on agricultural land. This saves farm fertilizer costs and reduces landfill costs at the pulp mills.
- Commercial laminated beams developed from Alberta spruce and pine are competing successfully world-wide with traditional wood species like Douglas Fir, which is not available in the province. This reduces the cost of raw materials by 20%, increasing the profitability and competitiveness of the manufacturers. The acceptance of spruce and pine laminated beams by the industry in Canada, the US and Japan has led to increased use and exports.
- Commercial roofing shakes from Alberta pine and spruce are competing successfully with traditional wood species such as cedar, which is not available in the province. The shake industry is now exporting about 60% of production.
- An artificial intelligence research group was established at the University of Alberta, dedicated to process and quality control and assurance, and production management of processes in Alberta pulp mills. The group will also address the development and commercialization of a computer system to monitor, regulate and control timber flow from stump to mill. This technology will improve quality and reduce production costs.
- An agri-fibre pulp process to produce a dietary supplement for the food industry was developed and commercialized. It uses straw to produce fibres for food or paper production. The plant employs 16 local residents and uses surplus straw. Another mill is expected to be built soon.
- The engineered wood products program established at the University of Alberta is developing high performance wood and synthetic materials from Alberta natural resources.

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The following outputs are expected to be achieved by the end of the 1998/99 fiscal year:

- Increase value-added to Alberta's forest resources resulting in an increase in employment to 1.4 jobs per thousand cubic metres of timber harvested.
- Improve forest resource recovery by 15% through higher utilization of small diameter and marginal wood and residues.
- Increase the financial leverage of the program to a ratio of 1:4.
- Fully integrate the composite wood products program of Forintek Canada Corp. and the Alberta Research Council.
- Expand the Mechanical Pulping Consortium to include research and development related to agrifibre-based and kraft pulping.
- Increase the value of OSB/MDF marketed offshore by 50% through the Wood Panel Export Development Alliance.
- Increase the value of engineered wood products (wood I- beam, laminated beam) marketed offshore by 30% through the Cooperative Overseas Market Development Alliance.
- Obtain regulatory approvals for using spruce and aspen as furnish for the manufacture of shakes and shingles.
- Develop an internationally accepted standard for using mechanical pulp in the manufacture of fine papers through the American Society for Testing and Materials (ASTM) program on long-term paper performance. This will in turn open new market opportunities for using Alberta CTMP.
- Develop a sustainable forest management certification standard that will lead to a recognized Canadian standard through the Canadian Standards Association (CSA) and an internationally recognized standard under ISO. This will help the Alberta pulp and paper industry to maintain and increase exports by certifying the sustainability of Alberta forest and management practices.

3.5.3 Economic Policy and Statistics

Introduction and Strategic Objectives

This section provides business information and analytical support to enhance competitiveness and aid decision making by Alberta businesses. It provides internal support analysis and policy research that ensures a supportive regulatory and policy environment for Alberta business.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

The Alberta Services Exports Survey was commissioned to determine the level, nature, and market destination of services exported from Alberta in 1995. This information will help the department develop policies and support for this growing export business.

Improvements were made to the Alberta Business Register, a comprehensive electronic database of over 170,000 Alberta companies including type of business in Alberta, location and number of employees.

1996/97 Plan

The Alberta Services Export Survey is a two-year initiative that will be completed in 1996/97. Further refinements will be made to the Alberta Business Register in 1996/97 and beyond.

3.5.4 Independent Business Development Program

Introduction and Strategic Objectives

This program provides data collection and trend analysis for Alberta industry with a focus on the development needs of small businesses (including home-based businesses) and on issues related to the start-up of new businesses.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

Data from the Small Business Database (SBDB) were made available to small business owners across Alberta, helping make this growing sector of our economy more competitive. The SBDB is a joint initiative which includes all provinces, territories and six federal departments or agencies.

1996/97 Plan

The development and enhancement of the SBDB will continue in cooperation with the Canadian Bankers Association. Research on small businesses will be done in collaboration with Western Diversification and the other western provinces.

3.5.5 Tourism Development Program

Introduction and Strategic Objectives

This program provides tourism development information to meet the needs of tourism operators, developers and investors, associations, municipalities and other governments in support of tourism investment decisions and a positive business climate for tourism.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

Product and market information assisted hotel and motel developers in southwestern Alberta and eco-tourism operators interested in developing backcountry locations.

Site investigations and economic impact studies assisted tourism development locations throughout the province. Offshore visitors to Alberta grew about 33% in 1995.

Alberta's tourism industry overall invested $260 million in new capital construction in 1995 generating 5438 person-years of employment.

1996/97 Plan

Efforts will continue to improve the regulatory and business climate for tourism in the province.

3.6 Alberta Education

Introduction

Education ensures that all Alberta students have the opportunity to acquire the knowledge, skills and attitudes to fulfill personal goals and contribute to society as a whole.

There are some 550,000 ECS to Grade 12 students in Alberta, served by about 2,000 schools and nearly 35,000 teachers. The annual cost of Alberta's basic education system is about $2.8 billion.

Alberta Education sets policy, curriculum and standards for the province's basic education system. It certifies teachers, provides funds for school boards, and capital funds for building, renovating or maintaining schools. It also administers Grade 12 diploma exams and achievement tests, and issues marks and graduation certificates to students.

School boards at the regional level set district policies, hire teachers and principals, and provide the courses and programs to students following the provincial curriculum and guidelines.

Table 3.5: Alberta Education

Related Scientific Activities Program Budget: 1996/97 - 1998/99

	1996/97	1997/98	1998/99
Performance Management and Reporting	321,000	289,000	289,000

Strategic Research Objectives

The Performance Management and Reporting program provides leadership and operational support to department management. Key aspects include developing and implementing accountability measures — indicators to assess, report on and improve educational performance.

The program is funded from general revenue funds of the provincial government. It is implemented primarily by in-house personnel, with some reliance on external consultants (about 20% of total program expenditures). External contractors are hired in open competitions through a call for proposals.

The program also involves: (1) preparing a provincial

performance report on education; (2) carrying out satisfaction surveys of educational stakeholder groups to provide qualitative feedback about key aspects of our basic education system; (3) analyzing social, political, economic and educational trends and issues; (4) undertaking impact/evaluation studies to determine policy effectiveness and efficiency; and (5) providing timely advice and support to the Minister, Deputy Minister and senior Education officials.

1995-96 Technology Accomplishments and Socio-Economic Benefits

Alberta Education collected and analyzed data on all the performance measures in the provincial business plan for education. The results achieved in the first year of the business plan were published in *The Results Report on the Three-Year Plan for Education, ECS to Grade 12, 1995.* These results were used to identify high performance areas, areas for improvement, and priorities for improvement. These were used in developing *Meeting the Challenge III,* the three year business plan for education, 1995/96-1998/99.

An important aspect of Alberta Education's performance measurement and reporting initiative is surveying key stakeholder groups. Stakeholder perceptions help improve the quality of education by identifying areas of strength and areas needing improvement. A strong basic education system prepares young people to be skilled and capable workers, and well-rounded citizens who contribute effectively to society.

Alberta-based partnership creates the classroom of the future

Students around the world are entering a new era of learning, and Alberta students are ahead of the pack thanks to an innovative multimedia educational pilot project. Project ELITE (Electronic Learning in Information Technologies in Education) is designed to deliver curriculum-specific social studies material through state-of-the-art broadband multimedia technology.

The not-for-profit project teams Nortel, a world leader in broadband network technologies (and Alberta's largest manufacturer), and Edmonton-based OZ New Media Inc., Canada's only broadband educational content developer. Together they bring to Project ELITE seven-figure funding, equipment, know-how, content, and project management.

Benefits include easy access for students to large volumes of up-to-date electronic materials, a reduction in materials preparation time for teachers, and the potential to create a global billion-dollar business for Alberta companies.

1996/97 Plan

The performance measurement and reporting initiative will continue.

3.7 Alberta Energy

Energy is fundamental to the ability of any industrial society to function effectively, but is particularly important in Alberta where an abundant and dependable supply of low cost energy is a key component of the "Alberta Advantage." The energy industries are the largest single contributors to the provincial economy with annual expenditures of more than $20 billion, and with direct and indirect employment of some 175,000 persons in Alberta.

Alberta Energy's research and technology development program is designed and organized as an industry-driven activity. Research priorities are established by a committee of industry representatives, and industry is involved to the fullest extent in the definition and conduct of 13 research programs, listed below.

Table 3.6: Alberta Energy

Projected Expenditures : **Alberta Energy Net Share Only**

(1000$)

	Research Programs	95/96 Estimate	96/97 Target	97/98 Target	98/99 Target
1.	In Situ Oil Sands	6,935	3,705	3,990	3,790
2.	Oil Sands Mining & Extraction	2,435	1,865	2,015	1,965
3.	Heavy Oil	445	2,625	2,916	2,940
4.	Bitumen & Heavy Oil Upgrading	1,605	1,520	1,800	1,800
5.	Conventional Oil	45	500	600	1,200
6.	Enhanced Oil Recovery	744	1,055	1,550	1,050
7.	Natural Gas	--	27	400	1,200
8.	Coal	600	450	450	450
9.	Hydrogen	1,000	1,000	1,500	1,500
10.	Renewable Energy	50	100	300	500
11.	Minerals	355	500	500	500
12.	Transportation & Marketing	60	250	250	25
13.	Greenhouse Gases	50	400	500	750
	Research Totals	**14,323**	**14,245**	**16,771**	**17,670**
	Related Scientific Activities	**4,175**	**4,175**	**4,175**	**4,175**
	TOTAL	**18,498**	**18,420**	**20,946**	**21,845**

3.7.1 In Situ Oil Sands

Introduction

The size of resource that could be proven by new in situ technology is 40 billion barrels in the Athabasca oil sands area, 10 billion in Cold Lake, and 10 billion barrels in Peace River. The royalty payments from development of this resource are expected to be $60 billion. There will also be other indirect economic and social benefits.

Strategic Research Objectives

The program is directed toward developing and demonstrating new recovery processes and developing refinements of existing operations for in situ oil sands. The recovery processes must have the ability to supply bitumen at costs competitive with other sources. The key elements are:

- Steam Assisted Gravity Drainage (SAGD) Process
- Low permeability application technology
- Steam confinement control
- Process application optimization
- Thermal Artificial Lift
- Water Re-Use Optimization
- Breakthrough technologies

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- After 18 years of research and development, SAGD technology is starting to be used commercially. At least 20 oil companies are involved in SAGD pilot and commercial projects that total close to $1 billion.
- Shell in Peace River and Amoco in Wabsca are evaluating the potential of top-down combustion technology, that was developed and optimized in the program. Use of this technology will enable additional deposits to be exploited.
- Texaco in Frog Lake is considering the application of Cold Production to a pool containing over 900 million barrels. A conservative estimate of production from this pool by this non-thermal method is 10% of the oil in place.
- Wascana Energy is currently field testing novel completion methods based on the "wormhole" concepts, which promises to save $75,000/well, in addition to significantly decreasing the cost of reservoir access.

- Novel technology was also developed for sand control. It prevents the sanding of wells and reduces costly pump repair and well maintenance (estimated at over $100K/well/year for wells experiencing sanding). Plans are underway to test this process in the field in partnership with a member company and a service company.

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The recovery process development program is industry-led and utilizes the research facilities and supporting technical expertise of the Alberta Research Council for the fundamental laboratory and lab pilot studies under the Alberta Department of Energy/Alberta Research Council Core Industry (AACI) Cooperative Program. The proposed in situ oil sands research program is divided into three sub-programs: (1) Reservoir Process Development, (2) Operations, (3) Institutional Research.

The field-oriented research and piloting is conducted in partnership with one or more companies.

A significant part of the upgrading program will be carried out in collaboration with CANMET, the Alberta Research Council, and Canadian Oil Sands Network for Research and Development (CONRAD). Part of the upgrading program will be conducted at universities to develop new upgrading concepts and understanding of reactions in upgrading.

3.7.2 Oil Sands Mining & Extraction

Introduction

Expanded production of oil sands bitumen will be essential in maintaining Alberta's role as the major Canadian source of liquid hydrocarbon feedstocks. Further development of the surface mineable oil sands, building on the success of the two existing commercial operations, will provide a substantial part of this increased production.

Strategic Research Objectives

The program addresses the two major challenges to the accelerated development of the surface mineable oil sands deposits:

- Further reductions in mining, extraction and transportation costs which will make it possible to develop ore bodies remote from the main plant sites, in addition to improving the economics of existing operations.
- The ability of oil sands projects to meet air emission regulations, and handle and dispose of extraction plant tailings in an environmentally acceptable manner.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

Increased production of oil sands is a key component to ensure a healthy energy and minerals industry. The availability of technology is a critical factor in ensuring that resources can be extracted economically and processed efficiently.

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- Demonstration and commercialization of the ATP process
- Development and demonstration of other alternative extraction processes such as the OSLO cold and warm water extraction processes, the Oleophilic Sieve process, and the Bitmin CCD process.
- High temperature froth treatment studies.
- Froth pipelining studies.
- Continuation of work with Fine Tailings Research Consortium, and field tests on methods of tailings remediation and reclamation of tailings ponds.
- Alternative extraction processes that do not require tailings settlement basins.
- Studies of the properties and treatment of water released from extraction processes and tailings ponds during reclamation of oil sands areas as natural self-sustaining environments.
- Control of atmospheric emissions from oil sands operations, particularly carbon dioxide (included in Greenhouse Gases program).

Breakthrough oil sands production technology now in commercial use

After 18 years of research and development, a breakthrough oil sands production technology is getting an enthusiastic reception from industry. The technology, called steam-assisted gravity drainage (SAGD), allows for the economical recovery of oil from oil sands that lie too deeply buried for surface mining. At least 20 oil companies are involved in SAGD pilot and commercial projects that total close to $1 billion.

SAGD involves drilling pairs of horizontal wells into the oil sands, one well above the other. The top well injects steam into the oil sands, heating up the oil and allowing it to flow into the bottom well from where it is pumped to the surface.

Research on SAGD began in 1977, spearheaded by the Alberta Oil Sands Technology and Research Authority (AOSTRA). It progressed from laboratory studies to large-scale testing at the Underground Test Facility in Fort McMurray. Without this work—and the perseverance of AOSTRA—it is unlikely the technology would have reached the current stage where it can be exploited by industry.

3.7.3 Heavy Oil

Introduction

Current estimates of Alberta heavy oil in-place are 1.5 billion cubic metres. About 0.2 billion cubic metres (13% of the resource) are considered established. It is possible that this recovery could be more than doubled by the successful development of recovery processes.

Strategic Research Objectives

The objective of this program is to develop and demonstrate recovery processes for heavy oil reservoirs. In many cases these reservoirs are thin and steam cannot be economically used. Process development is a medium- to long- term activity. The length of time to prove a technology varies with the process and reservoir in which the test is being conducted.

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The proposed heavy oil research program is divided into three sub-programs.

1. *Process Development*. Recovery process development for heavy oil is expected to require research support on a number of fronts including: gravity drainage processes using hydrocarbon vapour, steam and combustion and foamy oil. The studies will range from laboratory studies to selection of fields for trials.

2. *Operations*. Specific general improvements will be identified that have potential to reduce operational costs and generate additional business for Alberta manufacturing and support industries. The potential for other industries to use sand produced during oil recovery will be investigated.

3. *Institutional Research*. The AACI Program and the University /Industry programs will pursue novel breakthrough technologies applicable to heavy oil recovery.

3.7.4 Bitumen & Heavy Oil Upgrading

Introduction

The upgrading of bitumen and heavy oil to synthetic crude will become increasingly necessary as a source of feedstock for Alberta refineries. It also represents an important value-added activity. Increased product quality will be required to meet more stringent motor fuel specifications aimed at reducing ground level ozone in urban areas.

Strategic Research Objectives

The program is directed toward reducing synthetic crude production costs through development, demonstrating processes with lower capital and operating costs, and improving yield and product quality.

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While in most cases specific projects in this program have not yet been defined, the overall objective is to reduce the net cost of bitumen and heavy oil upgrading. The performance measures will therefore comprise decreases in capital and operating costs per barrel and/or increases in

yield and product quality. Specific milestones and performance measures will be developed for each project as these are defined in consultation with industry.

The departmental costs will be on average of 50% of the total costs except for the National Centre for Upgrading Technology (NCUT) which is 70% CANMET and 30% Alberta funding. Expected industry participants are oil sands producers and process developers.

3.7.5 Conventional Oil

Introduction

Reducing the cost of finding conventional oil is very relevant to adding new conventional reserves in Alberta. In addition, there is considerable potential for reducing development and operating costs, and for establishing new businesses to apply technology developed by this research.

Strategic Research Objectives

The conventional oil research program is designed to enhance the discovery and delineation of our oil resource, reservoir access and fluid handling. Specific projects include:

- Advanced finding methods.
- Horizontal well drilling and completions.
- Formation damage control.
- Fluid handling.

1995/96 Highlights—Technology Accomplishments and Socio-Economic Benefits

Conventional oil production is a significant component of Alberta's energy sector. In 1995/96, 349 million barrels of conventional oil were produced.

1996/97 Plan

Multi-client consortiums consisting of operating oil companies and research institutions will be used to address the different projects to be defined by the industry council.

3.7.6 Enhanced Oil Recovery

Introduction

Conventional light and medium oil originally in place in Alberta totals 7.0 billion cubic metres. Of this amount, approximately 2.1 billion cubic metres have been recovered. The remaining currently recoverable reserves are 0.4 billion cubic metres. Enhanced Oil Recovery has the potential to significantly increase remaining established reserves. This has significant direct and indirect economic and social benefits.

Strategic Research Objectives

The overall objective of enhanced oil recovery processes is to improve oil recovery and therefore increase the province's oil reserves. Research laboratory and field tests of these processes are necessary to quantify the increase in reserves and the economics.

The projects identified in this program are:

- Reservoir conformance improvement with gel foam.
- Mobility control with foam.
- $C0_2$ processes.
- Hydrocarbon miscible process enhancements.

1996/97 Plan

The laboratory study will be conducted by PRI with field experimentation by participating oil companies.

3.7.7 Natural Gas

Introduction

Natural gas is a premium fuel and although Alberta appears to have very large supplies, only 1.5 trillion cubic metres of the estimated 5.9 trillion cubic metres originally in place remain. At current annual production rates, this equates to a remaining supply life of 13 years or, if the most recent reserve addition rate is included, about 20 years. Developing enhanced recovery methods and new sources of gas is therefore very relevant to Alberta.

Strategic Research Objectives

The prime objective is to increase gas recovery and ensure a continued supply of natural gas.

Gas production research includes:

- Water abatement.
- Gas and gas product recovery by CO_2 and N_2 injection.
- Enhanced gas recovery from low pressure, low permeability reservoirs.
- CO_2 emissions re-use (included in Greenhouse Gases program).
- Coal bed methane potential.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

In 1995/96, gas production reached 4.6 trillion cubic feet.

1996/97 Plan

The first several years of these projects will be general potential scoping studies and will be multi-client supported. The third year will involve field tests with specific operators. Support from the department will be approximately at the 50% level.

3.7.8 Coal Technology

Introduction

Alberta's vast coal resources are used for low-cost electric power generation, and as a feedstock for value-added products, which are sold in Canadian and international markets.

Strategic Research Objectives

The Alberta Coal Research Program (ACRP) is designed to (1) enhance the competitive position of Alberta coal in domestic and international markets; (2) reduce emissions from coal use so that it remains an environmentally acceptable, low-cost option for power generation in Alberta; and (3) find new uses for Alberta coals.

The primary objective of the ACRP is to ensure that the Alberta coal industry has the technologies to maintain a sustainable, competitive presence in electric power generation and to maintain its competitiveness in national and international markets. The program also seeks to develop integrated resource strategies with other Alberta resource industries, to increase coal's versatility in industrial power generation and find value-added applications.

Types of research supported under the program are:

- Fundamental research.
- Pre-competitive technology development.
- Demonstration projects.

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Emphasis is given to short-term, results-oriented research.

The current priorities established by the Steering Committee are:

- Environmental impact reduction from the production and use of coals.
- Use of by-products and waste recovery.
- Coal quality.
- New, cost-effective coal technologies.

3.7.9 Hydrogen Technology

Introduction

Economical supplies of hydrogen and efficient hydrogen use are required for expanded production of synthetic crude from oil sands bitumen and heavy oil. Hydrogen is a critical feedstock for the upgrading of heavy oil and bitumen to a marketable synthetic crude, which will be increasingly required to augment conventional crude production. Hydrogen is also required in many other areas as Alberta's industrial base grows and diversifies.

Strategic Research Objectives

The Alberta Hydrogen Research Program is directed toward:

- Increasing the competitiveness of Alberta industry by lowering the cost of hydrogen through new or more efficient methods of hydrogen generation, transportation, and use.
- Promoting the expansion of Alberta's petroleum and oil sands industry by developing hydrogen technologies to increase the hydrogen/carbon ratio of Alberta's fossil fuels to meet present and future environmental requirements.
- Diversifying the Alberta economy by developing new commercial uses of hydrogen which build on Alberta's resource industry and broaden the provincial industrial base.

1996/97 Plan

The overall program direction and research priority areas are determined by the industry-led Alberta Hydrogen Technology Steering Committee. The program supports research ranging from fundamental research through pre-competitive technology development to demonstration projects, but with an emphasis on short-term, results-oriented projects. The current priorities identified by the Steering Committee are:

- Hydrogen production.
- New, improved methods
- Hydrogen separation technologies.

3.7.10 Renewable Energy

Introduction

Decentralized power generation from renewable energy sources can provide direct economic benefits by avoiding the need to transmit power from distant generating stations. It may also postpone the need to construct new conventional generation facilities.

Renewable energy utilization provides new opportunities in design, manufacture, installation and maintenance of equipment and systems. Export opportunities for equipment with improved performance should be excellent in the future, since other countries or parts of Canada with higher conventional energy costs will have adopted renewable energy on a larger scale than Alberta. Alberta designers and manufacturers should have an advantage in supplying systems and equipment for use under harsh weather conditions.

Solar, wind, and hydroelectric power generation involve no carbon dioxide production, while biomass energy produces no net CO_2 emissions apart from any conventional fuels used in growing, harvesting and processing. Providing a part of Alberta's energy requirements from renewable sources offers a means of limiting $C0_2$ emissions without reducing energy consumption.

Strategic Research Objectives

The program will enable the department to maintain an awareness of renewable energy developments elsewhere that may have applications to Alberta, advise on renewable energy issues, and handle inquiries and requests for financial assistance. Technical and economic feasibility studies will be supported on renewable energy applications that show promise of commercial viability in Alberta. As the program becomes established, emphasis will be given to shared cost projects with industry and other organizations.

1996/97 Plan

It is expected that much of the work with industry will be at the stage of equipment and systems development and field testing, including adaptation of technology developed elsewhere to Alberta conditions. However, basic and applied research at universities and research institutions may be supported when new concepts are identified that may offer longer range advantages to Alberta.

The extensive development of renewable energy in Alberta is inherently a long-range trend, and the maximum activity and benefits will fall in the 10-year and longer time period. However, a sufficient number of small scale applications — along with indicators of wider future applications — should be available by the end of three years to sustain industry and public interest.

3.7.11 Minerals

Introduction

The potential exists for precious metal, base metal, rare earth and uranium deposits in Alberta's Precambrian Shield and Phanerozoic sedimentary rocks. Discovery and characterization of such minerals will bring investment and economic development to the province. Indus-

trial minerals, such as salt, lime, gypsum and clays, are also important for Alberta's economic growth. The construction, chemical and paper industries in Alberta rely heavily on the availability and accessibility of certain industrial minerals in the province. There is potential for calcium, magnesium and potassium extraction from formation waters. While the industrial minerals industry is better established than the metallic mineral sector, it still requires assured and increasing supplies of raw materials to maintain and expand its internal and external markets.

Regardless of resource type, geological and resource evaluation studies are essential for providing the data needed to demonstrate the mineral potential of Alberta and attract mineral exploration and development interest in the province.

Strategic Research Objectives

The objective of the program is to maximize leverage from industry and the research community at large, focusing on expanding the knowledge base and understanding of resource emplacement of both metallic and industrial minerals. Program delivery will focus initially on:

- Regional mapping for mineral potential.
- Quaternary geology and drift prospecting.
- Geochemical and geophysical exploration.
- Commodity profiling.
- Operation and enhancement of a Mineral Information System for access by industry and the public.

The proposed program will comprise a geoscience component specifically geared to metallic and industrial minerals, the development of appropriate technologies to extract these resources economically, and economic analyses to evaluate market opportunities.

3.7.12 Transportation & Marketing

Introduction

Reduced transportation costs is one of the most important keys to increased market access and increased bitumen production in Alberta. This will have a large effect on jobs created and royalties generated for the province. Current cost of diluting and transporting bitumen is over $2 per barrel from Fort McMurray to Edmonton. The target is a system that reduces this cost by 50% and is not dependent on a limited supply of diluent.

Strategic Research Objectives

The objective of this research is development of an optimum product transportation system for bitumen. Research into diluents, partial upgrading, emulsion pipelining, combined carbon dioxide-bitumen pipelines, and other aspects affecting transportation and marketing of bitumen is needed.

1996/97 Plan

The first step is to establish an industry consortium to identify technology needs. This will be followed by the necessary laboratory and field tests for optimum bitumen transportation.

3.7.13 Greenhouse Gases

Introduction

A visible program of technology development will be essential to Alberta's energy industries in order to avoid punitive taxation or regulatory measures. (It has been widely publicized that Alberta is the largest per-capita producer of greenhouse gas emissions in Canada, and second only to Ontario in total amount.) A successful program of technology development will make it possible to accomplish reductions in CO_2 emissions at an affordable cost.

Strategic Research Objectives

The objective is to achieve significant overall reductions in CO_2 emissions from fuel production and use at the lowest (ideally negative) net cost. Major reductions at minimum cost are expected to require a multi-faceted approach using a mix of technologies for the different energy sectors.

The proposed research programs are designed to reduce atmospheric emissions of carbon dioxide from fuel production and use by two principal methods: (1) Capture and productive use of CO_2 from fuel combustion and of by-product $C0_2$ from fuel processing operations and (2) Reduction of produced CO_2 by process changes and increased energy efficiencies.

1996/97 Plan

The principal participants in research will be the oil sands, oil and gas, and coal producers, electric power utilities, process developers, and possibly chemical companies and pipeline operators. The departmental costs are expected to represent on average 30% of the total costs.

A Planning Group has been formed to organize a workshop to bring together various potential suppliers, marketers and users of CO_2. This workshop will attempt to identify commercial opportunities, infrastructure requirements and research needs.

3.8 Alberta Environmental Protection

Scientific and technical leadership is critical to supporting Alberta's goals of people, prosperity, and preservation. In the environmental area, R&D keeps Alberta at the forefront of new ideas and innovation and is essential for economic prosperity and enhanced quality of life. RSA activities are conducted strictly for operational purposes.

The Ministry uses information developed through R&D and RSA to anticipate, prevent, and mitigate environmental impacts, enhance our environment, and improve strategic decision making, thus contributing to the prosperity and quality of life enjoyed by Albertans. R&D, technology development, and RSA support the Ministry's core business: the protection and enhancement of the environment and management of renewable natural resources.

The core business is supported by the R&D and RSA programs in: Environmental Quality, Land and Forest Sustainability, Fish and Wildlife Sustainability, Interdepartmental Partnerships, Tire Recycling Management Board, and the Forest Resource Improvement Program.

R&D and RSA expenditures (Table 3.7) are an upfront investment in the sustainable management of our environment and renewable natural resources which leads to enhanced economic opportunities and diversification. This investment will assist the Ministry in maintaining a healthy environments, a high quality lifestyle, and a prosperous economy for the benefit of all Albertans.

Table 3.7: Alberta Environmental Protection

Research and Development (R&D) and Related Scientific Activities (RSA) Programs

($, thousands)

R&D Programs	1996/97	1997/98	1998/99
Environmental Quality (Air, Land, and Water)	1,535	1,405	1250
Land and Forest Sustainability	1,688[1]	1,584[1]	1,408[1]
Fish and Wildlife Sustainability	1,320	1,235	1095
AEP/AAFRD Partnership	2,563	2,403	2,136
Tire Recycling Management Board	1,000	1,000	1,000
Total R&D	**8,108**	**7,627**	**6,889**

RSA Programs			
Environmental Quality (Air, Land, and Water)	6,282	5,937	5,315
Forest and Land Sustainability	1,095	1,026	912
AEP/AAFRD Partnership	317	297	264
Forest Resource Improvement Program (FRIP)	7,460	5,823	2,960
Total RSA	**15,154**	**13,083**	**9,451[1]**
TOTAL R&D and RSA	**23,262**	**20,710**	**16,340**

3.8.1 Environmental Quality (Air, Land, and Water)

Introduction

To protect, enhance, and use our environment wisely, the Ministry needs to understand how our air, land and water is, or may be, affected by human activity.

The Environmental Quality program develops the science required for the sustainable management of Alberta's air, land, and water resources. It ensures that environmental protection and pollution control standards are achievable and have a solid scientific basis. It also provides the research that enables Alberta's water quality guidelines to be met without limiting industrial development. The program undertakes research into the impact of agricultural, municipal, and industrial activities on water quality and develops mitigative measures to meet the Prairie Provinces Water Board objectives for the Beaver, North Saskatchewan, Battle and South Saskatchewan rivers.

Strategic Research Objectives

- To develop the scientific information required for the sustainable management of Alberta's air, land and water resources.
- To provide scientific information in support of the department's operational activities directed at protecting the environment and maintaining air, land and water quality in Alberta.

1995/96 Highlights— Technology Accomplishments and Socio-Economic Benefits

- To aid in the reclamation of oil sands tailings, the Alberta Environmental Centre (AEC) has developed a technique to form stable aggregates comprising of oilsand sludges, overburden, sand and peat. These aggregates will form the beginnings of a new soil system.

New grass varieties for effective land reclamation

The Alberta Environmental Centre (AEC) has commercialized five native plant varieties for use in reclaiming disturbed sites in alpine areas. The new grasses will be used on land disturbed by mining, forestry, recreation and railway and road construction.

Covering disturbed mountain areas with vegetation prevents the damaging effects of erosion. However, commercial grasses need regular maintenance and often die in severe winters. Grasses that already grow in the mountains are more appropriate candidates for alpine reclamation. These new varieties are the result of AEC's long term research program aimed at developing native grass varieties for reclamation.

- Removal of toxic odorous air emissions (hydrogen sulphide, dimethyl sulphide and dimethyl disulphide) is an ongoing problem for the forest products and oil and gas industries. Current technology for the removal of these compounds is not cost-effective. Biofilters have been developed which have the potential to economically control these pollutants. Removal of these chemicals from air emissions will reduce the

nuisance and real hazards of these emissions and enable these industries to operate more efficiently with fewer restrictions.

- Five varieties of native plants have been commercialized for use in reclaiming high elevation disturbed sites in western Canada and potentially around the world. These grass varieties have provided an additional specialty crops for Alberta seed growers and are part of an emerging specialty seed export marked for Alberta's seed companies.

- The Bioreactor project, a four year study on bioremediation of contaminated soils, has developed the necessary technology for rapid biodegradation from hydrocarbons in soil or solid wastes. This technology will allow Alberta's oil industry to begin to remediate the over 100,000 sites presently unproductive due to contamination by hydrocarbons and other complex organic compounds.

1996/97 Plan

- Develop scientifically based environmental quality objectives and standards in cooperation with industry and the public, studies are underway to (1) characterize and control feedlot run-off; (2) characterize and control pulp and paper related chemicals; and (3) evaluate the impacts of pesticides, trace organics and heavy metals on the environment.

- Develop techniques to assist industry to reclaim lands affected by specified industrial strategies to ensure that they can be returned to an equivalent land capability, studies are underway to (1) restore ecosystems on disturbed sites; (2) dewater and reclaim oil sands fine tailings; (3) identify alternate methods of analyzing pesticides, hydrocarbons and trace organics; and (4) develop innovative methods of restoring productivity to highly contaminated lands.

- Develop processes which minimize waste going for disposal through (1) use of microbiological processes in waste treatment; (2) water and wastewater research and development; (3) waste incineration, including hospital waste incinerators, and studies to monitor and control chlorinated dioxin and furan emissions; and (4) evaluation of the effects of oil and gas drilling wastes on forest vegetation and soil.

- Assist the Ministry in the management of

Alberta's water resources, research will (1) improve guidelines to minimize the impact of instream activities, promote water conservation, and protect aquatic habitats; (2) evaluate the impacts of agriculture on surface waters in Alberta (Haynes Creek Watershed Project); (3) develop better methods to analyze heavy metals in surface waters; (4) study aquatic toxicology, the toxicology of biocides, and aquatic invertebrates; and (5) determine the impacts of forest land use changes on the hydrological cycle in terms of flood peaks, run-off volumes and water quality.

3.8.2 Land and Forest Sustainability

Introduction

The Ministry ensures forest and land sustainability by developing innovative research in science-based management, genetics and tree improvement, insect and disease control, wildfire management, forest growth and yield, soils, and silvicultural equipment development to ensure that forest management is based on sound scientific understanding.

The Land and Forest Sustainability program conducts and outsources innovative research in the areas of science-based forest management, genetics and tree improvement, insect and disease control, wildfire management, forest growth and yield, soils, and silvicultural equipment development for the Department. The program also works with its partners to obtain the latest information related to the stewardship of the natural resources found within Alberta's forests.

Strategic Research Objectives

- To develop scientific information on sustainable management of forests in Alberta.
- To develop scientific means and usage in the evaluation of the status of land and forest resources, and development of sustainable resource management strategies.

1995/96 Highlights— Technology Accomplishments and Socio-Economic Benefits

- Techniques were developed for constructing habitat suitability index models for aspen stands which incorporate forest age class data and the forest/wildlife database. These studies support the Alberta forest industry's efforts to better utilize the province's vast aspen resource.
- A research partnership with Canadian Forest Service has led to an aerial spruce budworm spraying technology geared towards Alberta's

forests and climate. Spraying previously used methods developed for New Brunswick. The new method has greatly increased the efficiency and cost-effectiveness of this control program and reduced the losses due to this insect.

- Forestry research has developed a new Escape Fire Analysis System (EFAS) for evaluating various fire suppression strategies for environmental impact, cost, and effectiveness. This will allow the most efficient and cost-effective suppression strategy to be used in each fire situation.

- Seed orchards are being developed for the production of improved seed for reforestation in Alberta. As well, improved guidelines were developed to reduce the risk of maladaptation of commercial tree stock due to seed movement, while maintaining genetic integrity of adapted native tree populations. This will help Alberta maintain an efficient and sustainable forest industry.

- Information was developed which will allow forest harvesting machinery to operate without compacting or degrading forest soils. This information will help maintain the long-term structural integrity and productivity of forest soils.

1996/97 Plan

- Develop management practices that ensure the maximize sustainable value of Alberta's forest lands, including: (1) assessment of the need for a Northern Regional Forest Research Project; (2) study of the effects of livestock, wildlife, and forest harvesting on forage production and lodgepole pine and aspen regeneration; (3) modeling soil compaction, de-compaction, and tree growth following harvest; (4) evaluation of snag densities and diameters in commercial forests; and (5) evaluation of stand health and site factors affecting aspen regeneration.

- Undertake and/or support research projects that further our understanding of the values found within Alberta's forests to ensure that the management of forest resources is sustainable. R&D supports the following activities: (1) deployment of manpower, equipment and aircraft to suppress wildfires; (2) reforestation of harvested and denuded Crown Lands to provincial standards; (3) development, review, and implementation of forest management standards and policies consistent with provincial legislation and sustainable forest management objectives; (4) tree breeding; (5) progeny testing; (5) seed orchard development; (7)

genetic pool conservation and monitoring; (8) technology transfer to nursery practices; (9) stand improvement through thinning and fertilization; (10) management of Public Lands; (11) review and approval of applications; (12) issuance of dispositions, and monitoring to ensure compliance with regulations; (13) review and approval of site reclamation plans; (14) monitoring and inspection of sites for compliance; (15) treatment of those areas where responsibility cannot be assigned; (16) development and management of back-country recreation opportunities; and (17) review and approval of commercial recreation proposals.

- Advance forest sciences within Alberta by funding university and private sector research that contributes to Alberta's global position as a leader in forest research by supporting the University of Alberta's Centre of Excellence in Sustainable Forest Management, Canada's first such centre ($12 million total estimated project cost).

3.8.3 Fish, Wildlife, and Parks Sustainability

Introduction

The Fish, Wildlife and Parks Sustainability program supports the Ministry in enhancing fish and wildlife resource sustainability by improving the means to protect and maintain healthy habitats and ecosystems, and in maintaining a system of protected and recreation areas for the benefit of all Albertans.

Strategic Research Objectives

- To develop scientific information in the conservation of Alberta's fish and wildlife resources.
- To develop scientific means to establish, operate, and maintain a system of protected and recreation areas, dedicated to Albertans.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- Humane trapping methods are vital to the continuation of a viable fur industry in Canada. A recent innovation in the Alberta Environmental Centre's humane trapping program is a computer-simulation program to test traps which could replace entirely or reduce the number of animals sacrificed during trap approval protocols.
- Recreational fishing forms a large part of the tourism industry in southern Alberta. Studies of fish in the Three Rivers Reservoir above the Oldman River Dam show that mercury levels remained below consumption limits. These find-

ings will enable the continued development of recreational activities and facilities associated with this water body.

- Winterkill in many Alberta lakes is a major limitation to the development of recreational fisheries. A surface aeration system for Alberta lakes susceptible to winterkill of fish populations was built and tested on Saskatoon Lake and several lakes in the Peace Region. The system was found effective, however its economic impact will depend upon its commercial use to maintain the fisheries in selected lakes.

1996/97 Plan

Research to assist in sustaining fish and wildlife populations and habitats, including:

- Evaluation of fish mercury contamination in the Three Rivers Reservoir.
- Aquatic invertebrate research to evaluate and compare monitoring methods for benthic macroinvertebrates in standing and flowing water bodies.
- Evaluation of hardwood logging on fisher and other furbearers in northeastern Alberta.
- Studies of winterkill in Alberta gamefish.
- Evaluation of trap effectiveness in collaboration with the Fur Institute of Canada.
- Research on the control of problem wildlife, such as skunks and pocket gophers.

3.8.4 AEP - AAFRD Partnership

Introduction

Partnerships between Alberta Environmental Protection and other government ministries to foster R&D are part of the Ministry's commitment to share expertise and facilities, and coordinate resources to meet the government's goals. Inter-departmental partnerships optimize the use of resources and provide an enhanced return on our R&D investments.

The partnership between Alberta Environmental Protection (AEP) and Alberta Agriculture, Food and Rural Development (AAFRD) ensures an effective research and service partnership in support of the environmental sustainability of the agriculture and food industry. It

began in 1979 with an agreement (amended in 1995) to address mutual R&D goals.

Strategic Research Objectives

To generate scientific information on:

- environmental pest management,
- environmental impact of the agriculture and food industry on the quality of air, water and land resources, and remedial practices,
- impact of non-agricultural industries on environmental resources essential to agriculture.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- Studies are being undertaken on the effects of livestock exposure to petroleum pollutants, sour gas, and hydrogen sulphide, including a literature review on the potential impact of the oil and gas industry on cattle production in Alberta. These studies will lead to methods to protect cattle from potentially hazardous substances and conditions, and will save cattle producers from unnecessary losses.
- Environmentally friendly agents/methods have been developed for the control of pests in greenhouse/indoor plantscapes. These methods will be considerably more cost-effective than conventional methods and will contribute to a safe and sustainable food supply for Albertans.
- A commercial decision support system to assess crop losses due to weeds was developed. These bioeconomic simulation models were developed for grass weeds in canola, wild oats in barley and wheat, and annual broadleaf weeds in cereal crops. They will allow farmers to make informed judgments as to the cost-effectiveness of various strategies of weed control.
- Commercial use of environmentally friendly control measures of major pests and plant diseases is being encouraged. For example, the Alberta Environmental Centre initiated a cooperative project with Alberta Agriculture, Food and Rural Development on control of woolly elm aphids in Saskatoons. The results of an integrated control study on root maggot in canola showed that increased seeding rates along with the use of DelPro® as seed treatment provided significant yield increases. These, along with other measures developed over the years, are now saving Alberta farmers millions of dollars in regained revenue annually.

1996/97 Plan

- To develop economic and environmentally sound pest management practices, including (1) weed management research in conventional and conservation tillage systems; (2) insect pest management research in field and horticultural crops; (3) disease management research in cereals, oilseeds, forages, special crops and forestry; and (4) research on biological control of weeds with arthropods and pathogens.

- To identify the environmental impact of the agricultural and food industry on the quality of air, water and land resources and to develop economical remedial practices including (1) native plant development for reclamation; (2) impact and management of feedlot runoff; (3) impacts of agriculture on surface water in Alberta (Haynes Creek Watershed Project); (4) development of small systems water supply; and (5) recirculating systems for aquaculture.

- To develop economically and environmentally sound principles to prevent or minimize the adverse impacts of non-agricultural industries and municipalities on the quality of air, water, and land resources essential to sustainable agriculture, including (1) inhalation toxicology research; (2) research and field investigation of the toxicology of petrochemicals and fossil fuels; (3) hazard assessment of diesel, crude oil and in cattle; (4) toxicity assessment of sour gas and hydrogen sulphide; (5) voluntary ingestion of crude oil by cattle; (6) impact of oil and gas in cattle; and (7) hazard assessment of glycol in cattle.

3.9 Alberta Family And Social Services

Introduction

The mission of Alberta Family and Social Services is to help families be responsible and accountable, adults independent, and to keep children safe; and to enhance the province's relationship with Aboriginal people in a manner that balances the interests of all Albertans.

Scientific activities are undertaken as needed, on a project basis. They include evaluation studies, policy option research, and general information geared towards improving government responses to the needs of service recipients and towards the efficiency and effectiveness of programs and services.

All of these activities are directly related to the Department's goals and mission. Most of these activities are related to operational issues of the Department or partner organizations such as Advanced Education and Career Development, Health, Education, Justice and Human Resources Development Canada.

Table 3.8: Alberta Family and Social Services

Projected Related Scientific Activities Budget

Projects	1996/97	1997/98	1998/99
Program and/or Operational Research	50,000	50,000	50,000
Evaluations of the Canada-Alberta Service Centres approach and of the Integrated Training Centres for Youth approach	50,000	50,000	50,000
Evaluations of Children Services	50,000	50,000	50,000
Evaluation of Urban Job Corps	25,000	25,000	25,000
Total	**175,000**	**175,000**	**175,000**

Strategic Research Objectives

All scientific activities undertaken or funded by the Alberta Family and Social Services are in the area of Related Scientific Activities (RSA). The Department is not involved in the area of Research and Development. The intent of the activities is to provide information on program performances and to serve for program development including program and policy changes, and changes in service delivery practices.

1996/97 Plan

Planned RSA activities include:

- Evaluations of the Canada-Alberta Service Centres approach and the Integrated Training Centres for Youth approach.
- Program and/or operational research.
- Evaluation of children's services.

3.10 Alberta Health

Alberta's health delivery system includes:

- Alberta Health
- Regional Health Authorities
- Provincial Mental Health Board
- Premier's Council on the Status of Persons with Disabilities
- Alberta Cancer Board
- Advisory committees
- Service provider organizaitons
- Individual health practitioners

Extensive restructuring of the health system is underway. Many factors are contributing to the need for fundamental change. They include: (1) Health is more than health services; employment, housing, education and environment have direct impacts on health. The capacity to cope and genetic endowments are other important determinants of health. (2) Consumers and communities want to be more involved in decisions about health and health services. (3) Cost containment and value for money spent is a requirement. (4) Advancing technology is changing the delivery of health services. (5) Information technology is providing easier access to expertise and information, contributing to better decisions. (6) The demography of Alberta is changing. (7) Different types of diseases need to be dealt with.

These factors influence the goods and services required to address health delivery. In the medical products and devices category alone, it is estimated that 80% of the goods used in Canada are imports. Alberta, however, has a growing health related industry community.

Timely, reliable, and relevant information from research and analysis is needed for Government, Regional Health Authorities, health service providers, industry, health sector stakeholders, and the public to make informed decisions on health and health services and to achieve provincial and regional health business plan objectives.

Alberta has established a position as a recognized centre of excellence in health research.

Researchers have achieved world acclaim for advances in areas such as cardiac treatment, infectious diseases, nerve regeneration, diabetes, the cancer genetics of and cell biology. The excellence of biomedical research in Alberta has attracted additional research funding from national and international granting agencies.

The $5.5 million health research funding provided by Alberta Health is a key but relatively modest amount of an estimated $45 million (from provincial sources) and $50.0 M (from external sources) in annual reserch funding. These amounts were estimated based on information in *University Research in Alberta* (Cloutier, 1995) and *Applied Health Research in Alberta: Investing in the Future* (Heacock, et al, 1993). The estimates exclude health research infrastructure costs funded by Advanced Education and Career Development.

Table 3.9: Alberta Health

Program Description	1995/96 ($ million)	1996/97 Estimates ($ million)	1997/98 Proposed ($ million)	1998/99 Proposed ($ million)
Alberta Health/Alberta Heritage Foundation for Medical Research - Health Research Collaboration	2.70	2.70	4.30	4.80
Alberta Cancer Board Cancer Research Initiative Program	2.80	2.80	3.80	5.80
Alberta Health's Related Scientific Activities (RSA)	1.63	1.63	1.63	1.63
• Extramural Studies	0.32	0.32	0.32	0.32
• Intramural Studies	0.03	0.03	0.03	0.03
• Administration of Extramural Activities	1.98	1.98	1.98	1.98
Subtotal				
TOTAL R&D and RSA	**7.48**	**7.48**	**12.18**	**12.58**

3.10.1 Alberta Health/Alberta Heritage Foundation for Medical Research Health Research Collaboration

Introduction

As of October 1, 1995, Alberta Health and the Alberta Heritage Foundation for Medical Research (AHFMR) entered into a Health Research Collaboration. Under the Collaboration, AHFMR assumes responsibility for:

- Development, support, review, updating and implementation of a Health Research Agenda for Alberta.
- Effective use of Health Research Funds through grant programs to realize the Health Research Agenda.
- A Health Technology Assessment function based on current best practices.
- Communication and dissemination of health research information.
- Supporting the development of the mechanisms necessary for utilization and outcomes monitoring and analysis.
- Coordinating health research activities through the Health Research Collaboration Committees.

The Health Research Collaboration is expected to result in:

- Support and enhancement of health research in Alberta, directed at improving the health status of the population and the management of the health system.
- Provision of a forum where researchers, the health system, consumers, and the private sector articulate health research priorities for the province, including areas of special interest and expertise, and support the conduct of this research through appropriate and strategic funding.
- Provision of relevant data, information, tools and research findings to the health stakeholder community, to promote evidence-based and outcomes-based decision making by consumers, providers and policy makers.
- Promotion of a focus on efficacy, efficiency and effectiveness in the use of health resources.
- Provision of effective linkages with health research organizations and findings elsewhere in Canada and internationally.
- Enhancement of the calibre of Alberta based health researchers.
- Enhancement of the profile of Alberta in the area of health research.

Strategic Research Objectives

- Facilitate and enhance health research, with particular emphasis on outcomes research and technology assessment.
- Link health researchers, funders, governments, Regional Health Authorities, the private sector research industry, and other health sector stakeholders in a common enterprise of developing a health research agenda for the province, conducting health research and achieving maximum leverage for funds and resources invested.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

The majority of studies are still ongoing. Valid health research requires large numbers of patients, and it takes time to recruit patients and analyze masses of data. However, several studies are almost complete and their benefits include:

- Development of a test to assess the driving skills of the elderly. The test is in the process of being commercialized.
- Application of teleconferencing technology to support brain-injured patients and their families in rural Alberta.
- Investigation of the role of prenatal exercise in avoiding complications during labour and birth.
- Investigation of the benefit to cities of having Aboriginal healthcare workers trained as Community Health Representatives.
- Development of a cost-effective method to identify hearing problems in infants.
- Development of methods to standardize effective treatment of children who arrive in emergency with acute asthma attacks.

1996/97 Plan

Alberta Health, as outlined in its 1996-1999 Business Plan, will *not* (1) have a primary role as a conductor of research, (2) administer grant programs, and (3) be the principal source of administrative data for research

The Business Plan reflects a full commitment to informed decision making and specifically articulates the following two strategies:

- Develop and implement strategies and define, collect and provide data for performance reporting, decision making and population health monitoring.

- Support health services research, technology assessment and communication of findings from Alberta and elsewhere.

3.10.2 Alberta Cancer Board — Cancer Research Initiative Program

Introduction

The health, social, and economic impact of cancer is staggering. One in three Albertans alive today will develop cancer. During the 15 year period prior to 1991, the number of new cancer patients diagnosed annually in Alberta doubled from approximately 4,000 to 7,966 (excluding non-melanoma skin cancer). Between 1991 and 2001, new cancer patients diagnosed each year are projected to increase another 50% to 11,908—a threefold increase in 25 years.

Breakthrough could lead to new drugs for cancer

It all started with worms. Two years ago, University of Alberta biochemistry professor Chris Bleackley attended a talk on cell death in worms. It gave him a fresh insight into his own research on cell death in human cells. The result? An incredible finding that could lead to new drugs against diseases such as diabetes and cancer.

"The majority of cells in the body are carrying around a time bomb," explains Dr. Bleackley. His group found the substance, called granzyme B, that acts as a detonator. Granzyme B goes in, flicks the switch and – boom! – the cell is dead.

The discovery is a triumph for basic research and a testament to the 10 years of painstaking work done by Dr. Bleackley to tease out the molecular secrets of killer cell activity. Pharmaceutical companies have already begun using granzyme B to screen material for use in drugs to regulate the killing mechanism.

Fail-safe cures or treatments exist for only about 10% of the 200 diseases which are called "cancer" — the remaining 90% of therapies are experimental. Consequently, the mandate for cancer research cannot be separated from the provision of good care. Cancer prevention, detection and treatment strategies are directly affected by new research-based findings. Research programs in basic (laboratory) and applied (clinical) cancer research are essential. Such research must address and help to integrate the key components of cancer control services, including prevention, detection, diagnosis, treatment and palliation.

To address this area of need, Alberta Health provides $2.8 million annually in research funding to the Alberta Cancer Board (ACB).

Strategic Research Objectives

To establish Alberta as a national and international leader in cancer research through scientific excellence, sharing of information and collaborative initiatives, and, therefore, to contribute to the Alberta advantage concept by promoting technology development, investing in people

and ideas, and contributing new jobs to a strong and sustainable economy. This will be accomplished by :

- Fostering research that strengthens and supports Alberta cancer care and education programs.
- Establishing, through the creation of an endowment, a supportive and stable environment to promote research excellence by securing dedicated long term funding.
- Establishing co-operative research program with biotechnology and pharmaceutical companies.
- Maintaining international standard of excellence through regular, authoritative reviews based on scientific merit.
- Avoiding duplication of effort through close relationships with Alberta universities, AHFMR, National Cancer Institute of Canada, and the Medical Research Council of Canada, cooperative ventures with the Regional Health Authorities and other agencies and collaborations among researchers.
- Targeting research programs with the potential to build on specialized resources available in Alberta (e.g. a centrally administered cancer control program, laboratory-bedside affinity research teams within clinical departments in cancer centres, and comprehensive and complete cancer registry).
- Targeting special cancer research initiatives to respond to the emerging health needs of Albertans through reallocation of resources.
- Supporting the development of promising young students, retention of productive researchers and recruitment of talented researchers — the future leaders of our health care system.
- Promote the transfer of new research findings/ discoveries/knowledge into routine use.
- Encouraging multidisciplinary research that complements patient care, prevention and education programs.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- The Radiobiology Research Group has developed an international reputation as one of the three top such groups in the world. Major discoveries made by this group on the relationship between radiation damage and tissue hypoxia are leading to new treatment strategies.
- An internationally recognized molecular genetics research group is exploring the increasingly important relationship between genetics and cancer in support of the integration of research into comprehensive care.
- Basic research done at the Southern Alberta Cancer Research Centre has led to advances in understanding many aspects of cancer including tumor invasion and metastasis, control of cell growth, mutations, and inheritance of cancer.
- Development of a comprehensive outcome evaluation program to measure the effectiveness of the Alberta Program for the Early Detection of Breast Cancer.

1996/97 Plan

In 1995, the ACB developed a research business plan that set the overall strategic direction for research. Key initiatives include:

- Establish an Alberta cancer research endowment fund. This $60 million fund will secure stable, long-term additional funding of approximately $3 million per year. It will be used to expand and strengthen the core cancer research program.
- Develop a gene therapy infrastructure program. The program is a $4.5 million investment over three years. The ACB and the Universities of Alberta and Calgary are committed to pooling their efforts and resources to foster this provincial program.
- Develop a provincial cancer clinical trials network. Currently, Alberta is dependent on clinical trials designed and managed outside the province. Under the new Regional Health Authority framework, and with recent advances in telecommunications and computerized database management, Alberta could build its own clinical trials network.
- Recruit and retain high calibre cancer researchers. The ACB will provide $500,000 annually in dedicated salary grant funding to foster recruitment of approximately three to four high calibre cancer research scientists.

3.11 Alberta Heritage Foundation for Medical Research

Introduction

The Alberta Heritage Foundation for Medical Research (AHFMR) was established by an Act of the Alberta Legislature in 1979. Its mandate was to establish and support a balanced, long-term program of medical research based in Alberta, and directed toward the discovery of new knowledge and the application of that new knowledge to improve the health of Albertans and others.

AHFMR was given an initial endowment of $300 million. Operations are funded from some of the investment earnings of the endowment to ensure that the fund remains intact. The Foundation is run by a Board of Trustees with representatives from the universities, the medical profession and the general community. The Scientific Advisory Council advises on policy and major funding thrusts to ensure activities supported are of the highest standards. In addition, every six years an International Board of Review assesses the productivity and effectiveness of AHFMR.

The 1993 International Review Board, a group of world renowned medical experts, assessed AHFMR and gave it an honours report card. The board acknowledged that AHFMR has made Alberta one of the leading centres for medical research in North America and that our researchers can hold their own with the best in the world.

Strategic Research Objectives

- Maintain AHFMR-supported strengths in basic biological research.
- Provide Alberta with the expertise and research resources to help address the challenges of the health system, including the priorities Alberta Health has established.
- Recruit research leaders to Alberta, fund training opportunities for Albertans, network with all the stake-holders to assist in a coordinated Alberta effort.
- Support a balanced portfolio of research, from laboratory studies of molecules to population health issues in the community.
- Support world class research.

- Continue technology commercialization funding to assist Albertans in bringing innovations to the marketplace. This includes additional funding and consultative assistance for projects which were successful in the early stages and will likely come to fruition in the next three years.

- Continue to provide leadership and advice to many national medical research agencies and related industries, and continue to promote Alberta through AHFMR's national and international reputation.

- Maintain communication programs for youth and public support of science and technology in Alberta.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- AHFMR researchers have earned international acclaim for their pioneering work in areas such as: heart attack therapy, transplantation of insulin-producing cells for diabetics, nerve regeneration, cholesterol studies, the cell biology and genetics of cancer, juvenile diabetes, drugs for viral infections including hepatitis B, electrical therapy for paralyzed people, vaccine development for malaria, meningitis, and diabetes, improved understanding of arthritis, causes of high blood pressure, diagnostic tests for ulcers, lupus, knee injury, cancer, and other conditions.

- AHFMR researchers have made Alberta a leading medical care centre in North America. They have established specialized patient care clinics for Alzheimer's disease, lupus, joint injuries, diabetes, thyroid disorders, cancer, heart disease, multiple sclerosis, hearing disorders, neonatal medicine, and other conditions.

- For every AHFMR dollar invested, medical researchers now attract more than two additional dollars in external funding from public and industry sources. These dollars would not have come to Alberta without AHFMR investment.

- Innovations coming out of AHFMR research labs have commercial spin-offs and become the basis for new companies. The AHFMR Technology Commercialization Program aids this process. It also supports innovators in industry.

- AHFMR has supported more than 3,000 research training positions for young people.

1996/97 Plan

- AHFMR will enable the recruitment of 8 or 10 new people, and at least 60 trainees, and further develop health research and Technology Assessment.
- Projected expenditures for all programs are $32.8 million, a significant increase. This could vary minimally depending on the results of recruitment and the opportunities for special initiatives which arise from the needs of Alberta Health, the universities and hospitals, and other stakeholders in Alberta or Canada.
- Expenditures are expected to increase to $33.8 million by 1998/99.

3.12 Alberta Research Council

The Alberta Research Council (ARC) has supported the economic development of Alberta for 75 years by promoting technology development and its application. ARC employs 320 people and works with more than 800 Alberta companies, ranging from small businesses to multinational companies, as well as municipal, provincial and federal government departments and agencies.

In carrying out its mission, it is conservatively estimated that ARC — through the success of its customers and partners — directly contributes more than $105 million annually to the provincial economy. In addition, ARC's work also yields social or indirect benefits, which contribute to the quality of life of Albertans.

A 1996 output performance survey of representative ARC client companies, determined ARC's investment to impact ratio to exceed 5 — more than $5 of wealth were created for each $1 invested by the government in ARC. Another survey measured satisfaction of ARC clients on a number of relevant criteria. Over 85% of clients were satisfied or very satisfied with the corporation's performance.

Key strategies are to increase ARC's mission effectiveness (wealth generated/grant investment) and the ratio of private sector R&D investments in targeted high-risk technology developments, to keep pace with our international competitors and to generate wealth and jobs in the province. ARC's investment impact ratio is estimated to increase from about 5 in 1995/96 to 6 in 1996/97, and the ratio of private sector R&D investment to grant funding from about 0.8:1 to 1:1.

Working together

Call them what you will – consortia, collaborative arrangements, joint ventures or partnerships – they are booming in Alberta's science and technology sector.

The Alberta Research Council (ARC) is an "old hand" at partnerships. Over the past decade, ARC and Alberta firms have formed some 70 joint research ventures, ranging from software development to engineering processes. Under this initiative, ARC and its partners share facilities and expertise to add value to promising ideas and move them to market.

Small and mid-size Alberta companies, in particular, benefit from ARC's commitment to commercialization. Through joint research ventures and the National Research Council's Industrial Research Assistance Program, they have direct and cost-effective access to laboratories, technical expertise and special services.

For example, ARC helped Edmonton-based Poly-Pacific Inc. develop an innovative system for removing paint from soft surfaces using tiny pellets made of recycled plastic. Stripping with plastic pellets is proving to be an attractive alternative to chemical stripping which is costly and poses environmental and occupational health hazards. The new technology diversified Poly-Pacific's product line and allowed it to make key moves into the international marketplace.

Poly-Pacific now fills regular orders to customers in the U.S., Europe and the U.K. New markets in Thailand and Hong Kong are being developed; a move into China is planned.

Table 3.10: ARC Business Goals and Targets ($ millions)

Performance Measurements	1995/96	1996/97	1997/98	1998/99
Wealth Creation	105	120	135	150
R&D Funding from Private Sector R&D	15.7	17.8	20.4	23.4
Core Grant	20.3	19.2	19.2	19.2
Mission Effectiveness Wealth/core Grant	5.2	6.2	7.0	7.8
Ratio of Private R&D/Core Grant Funding	**0.8**	**1.0**	**1.2**	**1.2**

ARC's core businesses are biotechnology, manufacturing technologies, natural resources and information technologies.

Table 3.11: Government Funding to ARC Programs ($ millions)

R&D Programs	1995/96	1996/97	1997/98	1998/99
Biotechnology	2.4	2.3	2.4	2.4
Manufacturing Technologies	10.1	9.3	9.1	9.1
Natural Resources	3.0	3.0	3.0	3.0
Information Technologies	4.8	4.6	4.7	4.7
TOTAL	**20.3**	**19.2**	**19.2**	**19.2**

3.12.1 Biotechnology

Introduction

The Alberta Research Council's Biotechnology business has one of the largest scale-up facilities in North America, where it conducts process engineering, fermentation optimization and scale-up manufacturing for biopharmaceuticals, enzymes and animal health products. It is also internationally renowned for its carbohydrate research.

Strategic Research Objectives

The strategic intent of ARC's Biotechnology business is to promote the development of a sustainable biotechnology industry in Alberta — achieved through the strategic management of ARC's technology base and its Fermentation Pilot Plant.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

Biopharmaceutical research originating from the University of Alberta is making its way to commercial practice via ARC's strategic alliances with Synsorb Biotech Inc. and Glycomed Inc.

- Synsorb Biotech Inc. (SBI) is a Calgary biotechnology company launched from ARC with university-based intellectual property. Phase II/III clinical trials for SYNSORB Pk, a potential treatment for hamburger disease, are in progress. The product has the potential to save the lives of those contracting the disease, for which there is now minimally effective treatment. Since its formation, SBI has created 10 new direct jobs and export sales of SYNSORB A&B are in the several $100,000 range. Potential sales for SYNSORB Pk are close to $100 million/year.

- California-based Glycomed Inc. is a leader in carbohydrate-based pharmaceuticals. In collaboration with ARC, the company is developing and testing compounds for potential treatment of inflammatory diseases. Its research program at ARC generates $3.1 million/year R&D investment in ARC, creating 25 direct jobs.

ARC's Biotechnology business has also attracted the interest of a large national and international biotechnology community. Through their support of ARC's Biotechnology business, these companies help ARC develop world-class biotechnology capability in the province, introduce new products of benefit to Alberta industry and create business opportunities in new areas. Examples include:

- An agreement signed by ARC with Central Biotech Inc. and Inland Marketing Inc.,

Saskatchewan, to develop and market animal health products, which have the potential to lead to an independent Canadian industry. As a result of this agreement, ARC's biotechnology facility is being upgraded to meet U.S. Department of Agriculture and Agriculture Canada requirements. Animal biologicals, pharmaceuticals and feed additives are a multi-billion dollar industry in North America.

- Contract manufacturing of an inoculant for peas and lentils with MicroBioRhizoGen Corporation, Saskatoon.

- Scale-up work of a vegetable oil, highly enriched in two fatty acids that play a key role in the development of neurological tissue. This will first be used as an additive to infant formula. The contractor is Martek Biosciences Corporation of Maryland.

1996/97 Plan

The development of a sustainable biotechnology industry in Alberta will be achieved through the strategic management of the ARC's technology base and its Fermentation Pilot Plant. Continuing stewardship of the SBI and the Glycomed alliances, and the acquisition and management of other technologies for the benefit of Alberta, is key to this strategy.

3.12.2 Manufacturing

Introduction

ARC's Manufacturing business provides product, process and equipment development for the manufacturing and energy service sectors. Capabilities and expertise include industrial chemicals, materials processing (including powdered metals, plastics and ceramics), industrial engineering and design, fluids processing, physical and computational modelling, and fluids separation technologies.

Strategic Research Objectives

The strategic intent of ARC's manufacturing sector is to stimulate the performance (exports, sales, profitability) and size (employment) of the Alberta manufacturing sector by working closely with progressive and innovative companies. The focus is on machinery and equipment, electrical and electronic components, industrial materials producers and users (plastic fabrication, resin production, etc.).

1995/96 Highlights - Technology Accomplishments and Socio-Economic Benefits

- Edmonton-based Poly-Pacific Inc. worked with ARC to develop a paint stripping technology using plastic pellets. This plastic injection moulding company has created 14 new jobs and is now marketing its environmentally friendly product

(product is made of recycled material and, in some instances, is a cost effective alternative to chemical stripping processes currently in use) in the US, Europe and southeast Asia.

- ESS-ELL Tool Company in Calgary worked with ARC to develop the capability and equipment to do its own wear and corrosion-resistant coatings, instead of shipping parts to the U.S. Originally intended for the oil and gas sector, HARD KOTE™ is also meeting a demand from the agriculture and automotive sectors throughout North America. The company is projecting sales of $125,000 during year one, and expects to create one new job.

- Working with ARC, Boundary Equipment Co. Ltd. of Edmonton developed a family of market-leading wear-resistant weld overlays. The company has created five new jobs and sees substantial dollar export potential for its new products.

1996/97 Plan

ARC plans to enhance its manufacturing activities in the areas of agrifood processing and medical appliances and devices.

It will focus on the commercialization of different applications of the hollow fibre and permeation gas separation technologies through contracts and licensing agreements.

Work will continue in the development of new magnesium technologies, including thixomolding.

An Advanced Manufacturing Institute (AMI) will be established to advance the global competitiveness of Alberta's manufacturers. This will be a joint initiative of ARC, the University of Calgary, the Southern Alberta Institute of Technology (SAIT) and the National Research Council's Industrial Research Assistance Program (IRAP).

3.12.3 Natural Resources

Introduction

ARC has international expertise in heavy oil and environmental technologies, forest products and pulp and paper. Specific programs include engineered wood products, pulp and paper technology, products and process improvement for energy-related industries, monitoring and remediation services and processes for the environmental industry, and energy breakthrough technologies for recovery and upgrading heavy oil and bitumen.

Strategic Research Objectives

- Stimulate the performance of wood products manufacturing companies in Alberta through the development and application of new/improved products and/or processes.
- Improve and enhance the competitive edge of Alberta's pulp and paper companies and related supply and service companies through the development and/or adaptation of new technology products and processes.
- Increase the development and utilization of Alberta's heavy oil and bitumen resources through the development of "breakthrough" technologies on in situ oil sands/heavy oil production and upgrading.
- Stimulate the environmental services industry in Alberta by partnering with companies to address environmental problems.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- A consortium agreement with Forintek Canada Corp. offers delivery of a national engineered wood composites program to Alberta panel products manufacturers. ARC expanded its panel development facilities, resulting in improved access and faster turnaround for clients for medium density fibreboard, overlays, oriented strandboard and large scale pilot runs of all panel products. ARC expects — through its clients and partners — to contribute an additional $10 million to Alberta's economy as a direct result of this expansion.

- ARC's Forest Products business sold 16 PressMAN© systems in Canada, the U.S., Europe, Chile and New Zealand, with sales exceeding $850,000. PressMAN© has also been installed in two new Alberta oriented strandboard plants. The unique system monitors pressing parameters of composite panel products. Local mills estimate that a cost savings of $600,000/mill was achieved in the past year by using research results to modify their press cycles.

Serendipity at work

Technology developed to upgrade Alberta coal is now being used for soil decontamination.

The "Clean Soil Process" was developed at the Alberta Research Council and grew out of research on the upgrading of Alberta coal. It turned out that the same process was ideal for cleaning up soil contaminated with hydrocarbons. In fact, this is the only technology capable of decontaminating soil at sites once occupied by manufactured gas plants. There are some 3,000 of these sites in the northeastern U.S. alone.

Now an Alberta company, Thermo Design Engineering Ltd., is commercializing the technology. In late 1996, four 500-tonne batches of contaminated soils will be run through TDE's equipment at a test area in Alberta. Large companies from Japan and Germany have confirmed their participation in the project, and multinationals from Belgium, France and Mexico have expressed interest.

- ARC/Alberta Department of Energy Core Industry (AACI) research program, operated by ARC, began another five-year, $15 million program. The work focusses on innovative research and development for recovery from horizontal wells, including thermal gravity processes, gas and solvent simulation, as well as key factors controlling cold production and reservoir maintenance, such as clay swelling and sand stability in wells.

- ARC performed the developmental work on the polymer feedstock for Camelot Superabsorbents Ltd. This Calgary company makes superabsorbent fibres for a variety of products, such as diapers. The superabsorbent market is increasing worldwide by 10 - 15 per cent annually. Camelot projects its production to reach eight million pounds this year and 100 million pounds in six years. The company began with a pilot facility and will construct a $5 million production plant in High River in 1996. It projects sales of $US 11 million in 1996, growing to $US 200 million in six years. By the end of 1996 Camelot will have created 50 jobs in Alberta, growing to 75 in 1997.

- Alberta Newsprint Company, Whitecourt, works with ARC to utilize de-inking sludge, a byproduct of de-inking technology, as a soil supplement. The company projects sales of $2.7 million/year on the sale of this new product and expects to hire three or four additional employees. Spin -off benefits to the province include use of a material that was previously considered waste.

- ARC's participation in the Canadian trade mission to India resulted in agreements being signed with the state-owned Oil and Natural Gas Corporation Ltd. and Oil India Limited. The agreements mark a major step toward long-term work to develop a heavy oil industry for that country, with the potential for millions of dollars in export sales opportunities for Alberta.

1996/97 Plan

- ARC will continue the alliance with Forintek and the forest products industry to deliver core research in coordination with Forintek's National Research Program in wood composites. The move into the new pilot plant facility will provide an expanded capability to manufacture large quantities of full sized panels for test marketing. The first such "production run" has been scheduled for Weyerhaeuser Alberta.

ARC will continue to work as an integral partner with the pulp and paper industry in Alberta. Key activities will focus on work with Alberta's mechanical pulping mills to improve operation of aeration basins, land application of sludge, sensing of dissolved oxygen in aeration basins, characterization and control of pitch, and advanced sensing techniques for control of refiners.

Work will continue on enhanced control of continuous digesters in kraft mills by application of non-intrusive techniques for measuring density and the characterization of wood extractives.

- Planned program activities in the heavy oil area include research in cold production, gas and solvent processes, thermal gravity drainage, as well as ongoing field testing and commercialization of processes by the AACI industry partners.

  The HC3 process, developed by ARC and the Alberta Department of Energy, will be adapted to support improvements in the commercial upgrading operations of Syncrude and Husky by minimizing fouling and catalyst consumption.

- With the transfer of management responsibility for the Alberta Environmental Centre (AEC) from Alberta Environmental Protection to ARC, a world class environmental team will be in place to greatly enhance research capabilities within the province. The combined facilities, people, and expertise of ARC and AEC will set Alberta apart as a focus for environmental technology advances.

3.12.4 Information Technologies

Introduction

ARC's Information Technologies experts are leaders in the development of knowledge-based systems for industry. Specific areas of expertise include: expert systems and neural networks, products and services for distributed systems, learning and collaborative systems, 3-D visualization and interaction, software engineering, and software for manufacturing.

Strategic Research Objectives

- Promote the improved performance of Alberta's information technologies sector in terms of wealth creation, export sales and jobs, by working with companies to develop products and services that will effectively penetrate the market.

- Maximize ARC's effectiveness in providing value to its customers by ensuring the optimum use of

the best contemporary information technologies by ARC and by all ARC employees.

- Improve the performance of Alberta-based companies through the use of computer networks, such as the Internet.

1995/96 Highlights — Technology Accomplishments and Socio-Economic Benefits

- Alberta's information technologies sector received a "kick-start" through ARC's collaborative work with private-sector companies such as Merak Inc., a Calgary software company. Following its joint research venture with ARC, Merak gained prominence as Canada's tenth fastest growing company. The company showed a profit of $190,000 in 1994 and created four new jobs.

- The Computer Modelling Group of Calgary has sold a unique reservoir visualization software in 20 countries. The 3-D visualization system was developed under two joint research ventures with ARC. Since completing its work with ARC in 1994, the company has hired 10 employees and increased its annual revenue by approximately $1 million.

- A joint research venture with Synapse Publishing Inc., Edmonton, has established a hypertext medical publishing capability for the Internet. The result is an easy-to-use system that provides access to current, quality medical information, along with the necessary searching and indexing tools. The heart of the Synapse system is a medicine-specific browser for the Internet called JANUS.

1996/97 Plan

ARC employees will work with technology development companies and service providers in the information technologies sector to develop new products and services using new and innovative information science. Areas of focus include:

- Advanced media and learning technologies.
- Health informatics.
- Communications and network applications.
- Pattern analysis and machine intelligence.
- Process automation and robotics.
- Integrated manufacturing.

3.13 Alberta Justice

Introduction

Alberta Justice is responsible for the administration of justice in the province. The Department provides support to the law enforcement agencies, courts for civil and criminal matters, incarceration and supervision of offenders, medical examiner services, legislative drafting, funding for legal aid and legal advice to government.

The business goals of the Department are:

- Maintain law and order in Alberta communities.
- Conduct criminal and civil proceedings in a fair and effective manner.
- Carry out the sentences of the court in a fair and effective manner.
- Provide effective legal services to the Government of Alberta.
- Provide access to social programs administered by Alberta Justice.
- Provide access to legal aid to those persons who are eligible.

Table 3.12: Alberta Justice
1996/97 to 1998/99 Expenditure Estimates

	1996/97	1997/98	1998/99
Research and Development			
Grant to Law Reform Institute	$320,000	$320,000	$320,000
Related Scientific Activities			
Corporate Support Services	$276,792	$259,492	$230,660
Correctional Services	85,440	80,100	71,200
Public Security	43,335	40,627	36,113
TOTAL	**$725,567**	**$700,219**	**$657,973**

Strategic Research Objectives

- Consider matters of law reform with a view to proposing the means by which the law may be made more useful and effective.
- Develop statistical information on the nature of crime and the administration of justice in the province.

1996/97 Plan

The Department will encourage continued research partnerships between various players of the justice system and between the private and public sectors. Research will be directly related to the delivery of justice services to the public through existing programs. The department will collaborate with the Law Reform Institute.

3.14 Alberta Transportation and Utilities

Introduction

Alberta Transportation and Utilities is the authority for the 13,800 kilometres of primary highways that connect Alberta to other provinces, the Northwest Territories and the United States. The highway system assists industry, visitors, and our citizens to travel efficiently within Alberta.

To enhance the safety of the traveling public and to reduce excessive wear on Alberta's highways, the department plays an important role in coordinating commercial transport operations. Disaster emergency preparedness and recovery are also a key responsibility of Alberta Transportation and Utilities. The Department guides and assists municipal governments in the development and testing of emergency response plans.

Table 3.13: Alberta Transportation and Utilities Research and Development (R&D) and Related Scientific Activities (RSA) Expenditures 1994-1999

Activity	Actual	Forecast in thousands of dollars			
	1994/95	1995/96	1996/97	1997/98	1998/99
R&D	$782	626	626	626	626
RSA	$5,145	4,273	4,273	4,273	4,273
TOTAL	**$5,927**	**4,889**	**4,889**	**4,889**	**4,889**

Strategic Research Objectives

The applied research program is aimed directly at improving the development, maintenance and operation of Alberta highways, bridges, airports and ferries.

1995/96 Highlights— Technology Accomplishments and Socio-Economic Benefits

- In 1995 two new test sections were constructed in Alberta to demonstrate the field performance of SUPERPAVE mix designs under the SHRP Asphalt Program.
- A model for bridge deck service life prediction was developed.

- Different designs of portable rumble strips were evaluated for their effectiveness and user acceptability.

1996/97 Plan

The internal component of the research program consists of projects identified by the operational areas of the Department. The projects in this category are carried out by in-house personnel or contractors. Continuing projects in the departmental Internal Applied Research Program include:

- New corrosion inhibitors.
- High performance concrete.
- Pavement response analysis affecting design.
- Wildlife/vehicle collision control.
- Fly-ash in concrete.
- Geometric factors in road safety modeling.
- Evaluation of alternative deicing chemicals.
- Pavement design theory.
- Cracksealer products and procedures.

The Cooperative Component of the Applied research program is undertaken jointly with other partners and provides the opportunity to address common problems at a significantly reduced cost to Alberta Transportation and Utilities. Cooperative partners are typically provincial and federal transportation departments and research agencies. Partnering with industry has also been pursued on individual projects.

Cooperative research at the national or international level is usually negotiated through the Research and Development Council of the Transportation Association of Canada (TAC). Cooperative research at the international level is negotiated through TAC. An example is Alberta's participation in the $150 million United States Strategic Highway Research Program (SHRP).

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